REPORT

OF THE

INDIAN IRRIGATION COMMISSION,

1901-1903.

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1901-03.

PART I.—GENERAL.

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COMMISSION APPOINTED TO REPORT ON THE IRRIGATION OF INDIA AS A PROTECTION AGAINST FAMINE.

COLONEL SIR COLIN C. SCOTT-MONCRIEFF, K.C.S.I., K.C.M.G., *President.*

MEMBERS:

SIR THOMAS HIGHAM, K.C.I.E., M. INST. C.E., Secretary to the Government of India in the Public Works Department, and Inspector General of Irrigation.

The HON'BLE MR. DENZIL C. J. IBBETSON, C.S.I., I.C.S., Chief Commissioner of the Central Provinces *(up to 18th February 1902).*

The HON'BLE MR. JOHN W. P. MUIR-MACKENZIE, I.C.S., Chief Secretary to the Government of Bombay *(after 13th January 1902).*

DIWAN BAHÁDUR P. RAJARATNA MUDALIAR, C.I.E., late Inspector General of Registration, Member of the Legislative Council of Madras.

SECRETARY:

MR. W. B. GORDON, M. INST. C.E., Superintending Engineer, Public Works Department, United Provinces of Agra and Oudh.

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PREFACE.

1. During the summer of 1901, the Governor-General in Council decided on the formation of a special Commission to report on the Irrigation of India as a protection against famine (see Resolution No. 13—61-16 of 13th September 1901).

The terms of reference to this Commission were as follows :—

(i) To ascertain the utility of irrigation under local conditions of agriculture, whether in generally increasing the produce of the land or in securing it from the effects of failure of rainfall.

(ii) To report upon the extent to which irrigation has been provided by works constructed by the State and the results—productive, protective, and financial—which have been attained.

(iii) To determine the scope which exists for further extensions of State irrigation works, with particular regard to such proposals for new works as may be laid before the Commission by local officers, and to estimate in general terms, after considering the results attained on completed projects and the data available from others which, whether sanctioned or not, have been investigated in sufficient detail, the probable net cost to the State of carrying out such extensions.

(iv) To consider the extent to which local capacities for irrigation have already been utilised by private individuals. There are in some districts a great number of private tanks or canals on which a considerable area of cultivation depends, and the question of stimulating private effort in extending such works deserves careful consideration. It may be found that when irrigation ordinarily yields too small a profit to attract the investments of private capital, the Government can extend it more economically by the grant of loans, or by foregoing the recovery of a portion of its loans, than by itself undertaking the construction of works. It may also be possible to assist the construction of works of this class by systematic arrangements for including them in the provincial programmes of relief works, and by executing them as far as may be possible by relief labourers on occasions of famine. Under this head also falls the important question of the extension of well cultivation, which in many tracts will probably afford greater and more reliable protection than any other form of irrigation work. The attention of the Commission is particularly invited to this branch of the subject.

(v) To consider the character and utility of the works on which relief labour has been employed during the late famine; to make recommendations, whenever possible, either for the completion or definite abandonment of such works as have not been completed; to examine the existing programmes of relief works, and to

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suggest the arrangements permanently required for revising and maintaining them in the most efficient manner so as to ensure the application of relief labour as far as may be possible to works which will have a real protective value. It is essential, with a view to the possible recurrence of famine, that in each province the arrangements for meeting it and for the employment of local labour should be in so advanced a state that operations may commence, as part of a continuous programme, without the dissipation of force or the delays resulting from hastily prepared and often imperfect schemes.

In the Resolution referred to the following instructions were also included for the guidance of the Commission :—

In considering proposals for new irrigation works the Commission will understand that greater importance may often be attached to the extent and reliability of the protection that will be afforded than to the merits of the schemes regarded as financial investments. The irrigation works hitherto constructed by the State in India have on the whole proved directly remunerative; but it is recognised that the programme of works of this kind may be approaching completion, and that the great storage works required for any considerable extension of irrigation in the tracts which are most exposed to famine must necessarily be more costly per acre protected, and therefore less remunerative, than the completed works which draw unfailing and perennial supplies from the great rivers in Northern and Southern India. As regards new works therefore the main question is not whether they will be likely to prove directly remunerative, but whether the net financial burden which they may impose on the State in the form of charges for interest and maintenance will be too high a price to pay for the protection against famine which they may be relied on to afford. It is from this point of view that the Commission should consider proposals for the extension of irrigation in districts in which cultivation is very insecure and precarious.

2. The Commission was formally constituted on the arrival of the President from England, and we held our first public meetings at Lahore on the 28th and 29th of October 1901. On the 30th we were present at Rasul at the opening of the Jhelum Canal by His Honour the Lieutenant-Governor of the Punjab, and thence we proceeded on our tour through India.

3. In order that we should be assisted in our inquiries by local knowledge and experience, the Local Government of each province visited by us had been desired to nominate an experienced Revenue Officer to be a temporary Member of the Commission, so long as we remained in the province. The following gentlemen therefore were temporarily our colleagues, and were of the greatest assistance to us, taking part in all our inquiries :—

In the Punjab.—The Hon'ble Mr. James Wilson, C.S.I., I.C.S., Settlement Commissioner.

In Bombay.—The Hon'ble Mr. J. W. P. Muir-Mackenzie, I.C.S., Chief Secretary to the Bombay Government.

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In Madras.—The Hon'ble Sir F. A. Nicholson, K.C.I.E., I.C.S., Senior Member of the Board of Revenue.

In the Central Provinces.—Mr. R. H. Craddock, C.S.I., I.C.S., Commissioner of Jubbulpore.

In Bengal.—Mr. C. G. H. Allen, I.C.S., Director of Land Records and Agriculture.

In the United Provinces of Agra and Oudh.—The Hon'ble Mr. D. T. Roberts, C.S.I., I.C.S., Senior Member of the Board of Revenue.

4. The Hon'ble Sir Denzil C. J. Ibbetson, K.C.S.I., accompanied us as a colleague through the earlier part of our inquiries, and from his great experience and intimate knowledge of revenue questions he rendered us the greatest assistance. When we left the Madras Presidency on the 19th February 1902, he was obliged to proceed to Calcutta to take up his duties as a Member of the Viceroy's Executive Council; and his place on the Commission was taken by Mr. Muir-Mackenzie who had accompanied us as local Member throughout Bombay, and afterwards as an additional Member through Madras.

5. During our tour we successively visited the following places where we held public inquiries and took evidence :—Lyallpur on the Chenab Canal, Sukkur in Sind, Jaipur and Ajmer in Rajputana, Rajkot, Kathiawar, Ahmedabad, Surat, Dhulia, Poona, Sholapur, Bijapur, Belgaum, Dharwar, Guntakal, Bangalore, Coimbatore, Madura, Tanjore, Madras, Rajahmundry, Hyderabad, Amraoti, Nagpur, Raipur, Jubbulpore, and Pachmarhi, where we arrived on the 18th March 1902.

6. Here we separated for the season. The President, whose services had been lent from the Scottish Office, was obliged to return to his duties in London. Mr. Muir-Mackenzie also went to England, on leave of absence, and Mr. Rajaratna Mudaliyar returned to Madras. During the recess, however, time was most usefully employed by Sir Thomas Higham up to the 26th May, when he resumed his duties as Secretary to Government, and by the Secretary, in collating and condensing the evidence already taken, and in obtaining further information on the subject of our inquiries.

7. In August the President terminated his service in the Scottish Office, and on the 15th October 1902 our Commission re-assembled, and we held meetings similar to those of the previous season at Patna, Muzaffarpur, Darbhanga, Purulia (Chota Nagpur), Calcutta, Cuttack, Allahabad, Lucknow, Jhansi, Gwalior, Agra, and Meerut. Altogether we held 91 sittings, and examined 425 witnesses. After the Delhi Durbar we settled at Lucknow, and there wrote this our report.

8. Before leaving Northern India for Rajputana in November 1901, we had the benefit of a lengthy interview with Sir Antony P. MacDonnell, G.C.S.I., who was on the eve of retiring from the Lieutenant-Governorship of the United Provinces of Agra and Oudh, and we learned his views on famine protective works.

9. From the first Burma was excluded from our tour of inquiry. The Konkan districts of Bombay, Coorg, Assam, and Eastern Bengal, are tracts in which there is no special need for irrigation. We inquired into the circumstances of such of the Native States as expressed a wish that we should do so, and we were

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glad of the opportunity of comparing their condition as regards irrigational practice with those of adjacent British territory. We devoted the greater part of our time to visiting those Provinces of India in which the extension of protective irrigation is most urgently required or presents the greatest difficulties. Time and distance precluded us from visiting Baluchistan.

10. We desire to acknowledge the courtsey and hospitality of His Highness the Maharaja of Jaipur, His Highness the Maharaja of Mysore, His Highness the Nizam, and His Highness the Maharaja Scindia, who invited us to their capitals and gave us opportunities for inspecting important works and for obtaining the evidence of many of the high officials of their States. At Jaipur, Ajmer, Gwalior, and Rajkot, we had the advantage of meeting the representatives of many of the States of Rajputana, Central India, and Kathiawar. We are indebted to the Durbars of all the States upon which we have reported for the trouble which they have taken in preparing the information laid before us and for the readiness with which they placed it at our disposal.

11. When in Bengal, we visited Darbhanga by the courteous invitation of the Maharaja, which we desire cordially to acknowledge. We had not the advantage of meeting the Maharaja, as his duties as a Member of the Police Commission necessitated his absence, but we obtained much interesting information as to the practice of irrigation on his estates.

12. As it was evident from the first that our inquiries would be extended over two cold seasons, and that we should not be in a position to submit our final report before the close of the financial year 1902-1903, we addressed to the Government of India, soon after completing our inquiries in each province, an *ad interim* communication, in which we offered opinions or made recommendations in respect of the most urgent or important questions which had been brought to our notice, and on which it appeared desirable that action should be taken without delay. We have referred in the Provincial Chapters of this report to the most important of these recommendations and are glad to acknowledge the prompt attention which has been accorded to them.

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REPORT

OF THE

INDIAN IRRIGATION COMMISSION.

PART I.—GENERAL.

CHAPTER I.—PRELIMINARY SURVEY.

SECTION I.—CONDITIONS AFFECTING THE USE AND VALUE OF IRRIGATION IN INDIA.

1. *Introductory.*—The vast extent of area embraced by our inquiries and the extreme diversity of local conditions preclude us from attempting, in this preliminary survey, more than a general description of the conditions which have led to the practice of irrigation in India from time immemorial. The actual utility of irrigation, or, as it is defined in the first of our terms of reference, its effect in increasing the produce of the land and in securing it against failure of the rainfall, must be left for subsequent consideration. We shall refer to it when we come to deal more in detail with the circumstances of each province or tract, and to consider the expenditure which may reasonably be incurred by the State on the construction of irrigation works as a protection against drought.

2. The main factors determining the use and value of irrigation in any part of India, whether from a purely productive or from a famine-protective point of view, are the rainfall, the soil, and the classes of crops suited to the soil, climate, and other local conditions. The rainfall may be so abundant and assured as to render irrigation superfluous, and even injurious; or, though ordinarily sufficient, it may be so liable to periodical failure or unseasonable incidence as to call for irrigation as a protection against its uncertainty; or it may in all years be so scanty as to make cultivation impossible without irrigation. The soil may be so inferior that the increased yield due to irrigation would not repay the cost of providing it; or it may be so retentive of moisture as to render artificial waterings unnecessary except in the driest year. The crop best suited to the locality and to the means of the cultivator may be rice, which in general benefits by a plentiful application of water, however heavy the rainfall; or it may be sugarcane or a garden crop, which in but few parts of India can be grown without irrigation; or wheat, which, in the absence of winter rains, requires as a rule at least three or four waterings to ensure a full crop. On the other hand, it may be barley or gram, which only require irrigation in a dry year; or cotton, which, over the greater part of India, is rarely irrigated even in a year of drought.

3. *The rainfall of India.*—The rainfall is not only a main factor in determining the value of irrigation, it is in itself the primary source of all means of supplying it. It is essential, therefore, that at the outset of our report we should describe, however briefly, the chief characteristics of the rainfall of India—its unequal distribution throughout the seasons, its still more irregular distribution over the surface of the country, and its liability to failure or serious deficiency.

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It will suffice to state the facts as we find them, avoiding as far as possible all reference to causes and influencing conditions.

4. *Seasonal distribution.*—By far the greater part of the rainfall is received between June and October, the period of the south-west monsoon. This is the chief season of rain over most of the peninsula, and over almost the whole of what is known as Northern India—the area between the Himalayas and the Vindhyas, containing the great alluvial plains of the Ganges and Indus rivers. Over a great part of the western half of Peninsular India, including nearly the whole of the Bombay Presidency, the rainfall is practically confined to this season.

5. In the south-eastern portion of the peninsula the season of heaviest rainfall is from October to December, the period of the north-east monsoon. In most years, the Central Provinces, Berar, and Hyderabad, also receive during this season some showers of rain, which, though usually small in amount, are of great agricultural value, especially to the wheat-growing districts.

6. The latter part of the winter and earlier spring months are the season of the winter rainfall of Northern India. The extreme north-western districts receive at this period about half their average rainfall; and on all the outer ranges of the Himalayas, in the submontane districts, on the plains of the Punjab, and over the north-western districts of the United Provinces, rain, sometimes heavy, occurs during these months. It extends, though somewhat less frequently and much less heavily, over the remainder of the United Provinces, occasionally reaching Bengal and the northern provinces of the peninsula.

7. During the hot weather, from March to May or June, thunderstorms are frequent in Bengal, and in and near the hills of Northern India; while to Southern India also, at this season, the 'mango showers' give a few inches of rain. But the Bombay Presidency and the plains of North-Western India receive practically no rain during these months.

8. *Geographical distribution.*—The general distribution of the annual rainfall is shown on the map of India which accompanies this report. One of the zones of heaviest rainfall lies naturally along the western coast of the main peninsula, where the monsoon striking the Western Ghats precipitates on their outer slopes an average rainfall of 100 to 250 inches. A second zone of heavy rainfall extends along the outer ranges of the Himalayas, widening out south of Sikkim to include Eastern and Lower Bengal, and Assam where, at Cherapunji in the Khasi hills, the annual recorded rainfall averages 461 inches.

9. From the Bay of Bengal to the western boundary of Bhopal in Central India, and from the Himalayas in the north to the Godavari in the south, stretches a wide tract of moderately high rainfall (40 to 70 inches). From Benares an offshoot runs up to the north-west through the Himalayan submontane districts nearly to the Indus river. In the south of the peninsula there are also two narrow strips with rainfalls of over 40 inches: one on the east coast, from the north of Madras to the south of Tanjore; the other lying along the eastern side of the Western Ghats, and extending northwards as far as Baroda. The remainder of India, excepting a small portion of Kathiawar, has a rainfall below 40 inches.

10. *Tracts with low average rainfall.*—The blue lines upon the map show clearly the rapidity with which the rainfall decreases, from over 100 inches to under 25 inches, as the clouds drift eastward from the summits of the Western Ghats; leaving a long strip of varying width, extending from Kotah in Rajputana to Cape Comorin in the extreme south of the peninsula, in which the rainfall is both scanty and precarious. They show also the less rapid, but still steady, decline in the rainfall of North-Western India, from the 40-inch rainfall line which passes through the western districts of the United Provinces, to the 5-inch line which traverses the State of Bahawalpur.

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11. *Variability of the rainfall.*—The average rainfall over the whole of India, excluding the Himalayas and Burma, has been computed at 42 inches in the year; that is to say, "such would be the depth of the sheet of water, if the whole quantity that falls on this area were equally distributed over its whole surface instead of being concentrated in certain provinces to the great deprivation of others."* Considering in this way the country as a whole, the rainfall may be said to vary but little from year to year, the greatest known variation amounting to under 7 inches in excess or defect of the general average of 42 inches. But if separate tracts are considered, it is found that in many parts of India the rainfall is liable to very great variations, which increase as the area of the tract is diminished, and become still more marked in the case of individual rainfall stations.

12. *Liability to deficiency.*—The degree to which the rainfall of any year is liable to be so seriously in defect as to cause injury to the crops may be greater in one tract than in another with a very similar average rainfall; but, speaking generally, it may be said that the lower the rainfall the greater its liability to serious deficiency from the average. Where, however, the annual rainfall is below 10 or 12 inches, cultivation becomes practically impossible without irrigation. In parts of such tracts which are devoted to pasturing cattle, high prices or the drying up of natural grasses may lead to distress and famine, but famine from failure of crops need not be apprehended. On the other hand, in Eastern Bengal and Assam, and in the narrow strip between the Western Ghats and the Arabian Sea, the rainfall, which exceeds 70 inches, has always been so abundant that the chance of its serious failure may be regarded as extremely remote. Between these areas, in which the crops are thus rendered safe by exclusive reliance on irrigation or by an assured and abundant rainfall, lies a vast tract of nearly a million square miles, of which, in the absence of irrigation, no portion can be deemed absolutely secure against the uncertainties of the seasons and the scourge of famine.

13. Within this tract the annual rainfall is liable to extraordinary variations. At many recording stations annual rainfalls of less than half the average are not uncommon; while at some, less than one-fourth the normal amount has been recorded in a year of severe drought. On the other hand, at many stations liable to these serious deficiencies the amount received in the year may equal and even exceed twice the normal. Some parts of the country, in fact, suffer as often, if not so severely, from excessive as from deficient rainfall. This is a condition which will not be overlooked when we come to discuss the value of irrigation in certain localities; but we are now considering only the liability of the various portions of this large area to receive a rainfall seriously in defect of the normal. A rainfall considerably below the average will no doubt, if favourably distributed, often produce a fair crop, while even an abundant rainfall may, if it is unfavourably distributed, lead to scarcity or famine. Tracts, again, in which the suffering from famine has at times been most intense, are not necessarily those in which the rainfall is most liable to periodical defect. On the contrary, the effects of drought when it does come are felt most in tracts like Gujerat, Malwa, and part of the Central Provinces, which owing to the sufficiency of the rainfall over a long series of years have come to be regarded as immune, and where the protection of the country by irrigation has in consequence been neglected. The quality of the soil, the classes of crops cultivated, and the character and resources of the people, are also factors which greatly modify the effects of a deficiency of the rainfall. But, as a general rule, tracts in which the rainfall is most liable to be in considerable defect from the average are those in which famines are most frequent, and the injuries from drought, in the aggregate, greatest. The frequency, therefore, with which the rainfall in any tract falls seriously below the normal may be taken as the best general index of its need for protection by means of irrigation works.

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* *Climates and Weather of India*, by H. F. Blanford, F.R.S., late Meteorological Reporter to the Government of India.

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14. The degree of least defect from the average which would, as a rule, cause injury to the crops is not easy to determine even for a given locality, and it is still more difficult to fix any general rule; but, for comparative purposes at least, it will be sufficiently correct to say that a deficiency of 25 per cent. would be likely to cause some injury, and that a deficiency of 40 per cent. would generally cause serious injury. The former we may call a dry year, and the latter a year of severe drought. A deficiency of 40 per cent. on a rainfall of 45 inches would no doubt still leave a rainfall of 27 inches, while the same deficiency on a rainfall of 25 inches would leave only 15; but in the former case rice would almost invariably be the prevailing crop, and for it at least twice as much rain is required as for an ordinary crop of cotton or millet. Indeed there are some exceptional tracts, such as parts of Gujerat, in which a rainfall of 15 inches, or less than half the normal, has been found sufficient to give a fair crop when its incidence was seasonable.

15. From the records of a number of rainfall stations which have been supplied to us by the Meteorological Department, extending back for periods varying from twenty-five to fifty years, we find that the average frequency of the occurrence of dry years and of years of severe drought at stations in different localities varies as shown below :—

Locality or tract.	Average annual rainfall. Inches.	Number of dry years or years of severe drought that may be expected in 50 years.		Locality or tract.	Average annual rainfall. Inches.	Number of dry years or years of severe drought that may be expected in 50 years.	
		Dry years, including years of severe drought.	Years of severe drought.			Dry years, including years of severe drought.	Years of severe drought.
NORTHERN INDIA.				PENINSULAR INDIA.			
Orissa	59	5	0	Central Provinces, East	55	6	0
Chota Nagpur	54	4	1	Satara, Belgaum, Dharwar.	42	4	1
Central Bengal	56	6	1	Central Provinces, West and Central.	47	7	2
Bihar	48	10	3	Madras, South and Central.	31	7	2
United Provinces, Submontane.	45	10	3	Mysore	34	9	3
United Provinces, East	41	10	3	Madras, North Coast	42	10	3
Punjab, Submontane	33	10	4	Berar	35	10	3
British Bundelkhand	36	10	5	East Coast, Central	33	9	4
United Provinces, West	29	10	5	Gujerat	44	10	4
„ „ Central	37	12	5	Hyderabad, North	35	11	5
Punjab, South-East	23	13	5	Sholapur, Bijapur, and Ahmadnagar.	26	11	6
„ Central	23	13	6	Madras Deccan	25	13	7
Ajmer-Merwara	20	11	6	Hyderabad, South-East	26	11	8
Punjab, West	10	14	9				

16. *Soils.*—The varieties of soils to be found throughout India are innumerable, but, with the exception of one important class, the cultivated soils are generally suitable for irrigation. It will be sufficient to recognize the broad distinctions between the main varieties characteristic of the principal geological divisions—the alluvial, the Deccan trap, and the crystalline and sandstone formations.

17. *The alluvial tract.*—The alluvial formation covers the greater part of Northern India, from the foot of the Himalayas to the northern slopes of the

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Vindhyas, and extends in a narrow fringe round the coast line of the peninsula, increasing in width at the deltas of the great rivers which flow down from the Western Ghats or the table land of Central India. It occupies the greater parts of Sind, the Punjab, the United Provinces, and Bengal, and of the Godavari, Kistna, and Tanjore districts of Madras. The substrata consist usually of alternate layers of sand and clay, but sometimes, especially in Bengal, the sand beneath the upper layer of loam is of unknown depth. The surface shows every variety of soil, from the blown sands of the western deserts, to the rich loam and stiff clay of the Ganges Valley, or the fertile black loam of the Kistna and Godavari deltas. But the prevailing soil is a yellow or red-brown loam which, in general, takes water freely and yields a largely increased outturn under irrigation.

18. There are, however, in the Punjab and United Provinces, numerous irregularly distributed tracts which have been rendered worthless for cultivation by the soil containing an excess of soluble salts—sulphates and carbonates of soda. Under conditions favourable to evaporation the salts accumulate on the surface, covering it with a white efflorescence locally known as *reh* or *kallar*. Irrigation, if water is applied too freely in the neighbourhood of such tracts, leads to an increase of the efflorescence; but it has not been found to increase materially the extent of its area.

19. *The Deccan trap.*—The Deccan trap formation covers an area of about 200,000 square miles in the north-western part of Peninsular India. It comprises almost the whole of the Bombay Presidency (including Kathiawar), the whole of Berar, the western third of the Central Provinces, and half of Hyderabad and Central India. Within the ranges of the Western Ghats and Satpuras, numerous varieties of soils are to be found, varying from the light sandy or gravelly soils of the ridges, to the rich yellow or red loams of the inner valleys of the hills. Elsewhere in this wide tract, black cotton soil prevails. It is so called from its colour and from its suitability to the cultivation of cotton. It varies considerably in colour, consistency, and fertility, but all varieties are highly retentive of moisture. When dried by the heat of the sun, the soil contracts to an unusual extent, seaming the surface of the country with cracks to a depth of several feet; and in this condition the most fertile varieties crumble into small and friable fragments. To the black cotton soils generally, irrigation is not suited. But to many crops it can be applied freely and with profit to the cultivator, when the soil is not of great depth and where the substratum affords good natural drainage; even in the deeper soils rice can be irrigated with advantage; and, under all conditions of depth and subsoil, irrigation is useful in affording the means of sowing a crop in a year of drought.

20. Black cotton soils are also to be found outside the area of the Deccan trap, generally in the valleys of streams and rivers. In such cases the soils are invariably alluvial and closely resemble, though they may not be identical with, the deposits similarly formed within the trap area. As a rule, owing to the greater depth of the subsoil and to its overlying an impervious substratum, these soils are less suited to irrigation than the 'sedentary' deposits, or soils formed *in situ* in the trap area. The chief districts outside the trap formation in which black cotton soils predominate are Bellary, Kurnool, and Cuddapah, in Madras; Surat and Broach, in Bombay; and Jalaun and Banda, in the United Provinces.

21. *The crystalline tract.*—The crystalline and sandstone formations occupy the whole of Peninsular India outside the area of the Deccan trap and the narrow strip of coast alluvium. Their area comprises almost the whole of the Madras Presidency; the State of Mysore; half of Hyderabad; two-thirds of the Central Provinces; with the Bengal Divisions of Orissa and Chota Nagpur. Northward it extends into and includes the whole or the greater part of the Sonthal Parganas and Birbhum districts of Bengal, the Mirzapur, Jhansi, and Hamirpur districts of the United Provinces, the Baghelkhand States of Central India, and the eastern half of Rajputana. The prevailing soils vary from a dark red loam in the bottoms, to the light sandy

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or stony soils of the arid uplands which produce the poorest of crops. The better classes of soils in this formation repay the cost of irrigation even more abundantly than the yellow loam of the alluvial tract of Northern India.

22. *The principal crops.*—The crops may be divided broadly into two classes: the autumn crops, sown in the spring or summer and harvested in the autumn; and the spring crops, sown in the autumn and harvested in the spring. These are known throughout the greater part of India as the *kharif* and *rabi* crops. In Madras, however, they are called first and second crops. Both in Northern and Southern India the autumn crops are mainly millets, pulses, and rice. The principal spring crops are, in Northern India, wheat, barley, linseed, and gram; and in Southern India, millets, rice, jute, and gingelly. The wheat area may be divided roughly from the spring millets and spring rice area by a line drawn from Bombay round the southern extremity of the Central Provinces and through the Patna district in Bihar.

23. The crops which are mainly or in a great measure dependent upon irrigation to ensure a full outturn in an average year are rice, wheat, and barley; sugarcane and garden crops; and indigo, where it is grown as an autumn crop. Cotton, when grown in black soil, and some of the staple *kharif* millets are said to receive but little benefit from irrigation even in a dry year.

Section II.—NATURAL FACILITIES FOR IRRIGATION.

24. *The alluvial tract.*—Each of the three great soil divisions referred to in the previous section is characterized by special facilities, or by its lack of facilities, for irrigation. The level surface of the alluvial plains admits of their absorbing a large percentage of the rainfall; and except in the deserts of the Punjab and Rajputana, the subsoil water is generally close enough to the surface to place the cost of lifting it within the means of the cultivator. In many parts of the Eastern Gangetic Valley, the subsoil consists as we have said of sand to an unknown depth, but elsewhere the substrata are usually suitable for the construction of wells.

25. These plains, again, are traversed by all the great perennial rivers whose sources lie in the snows and glaciers of the Himalayas or under the assured and abundant rainfall of the Western Ghats; while the level surface of the country presents no serious obstacle to distributing the river-waters over the length and breadth of the land. So marked are these facilities for the construction of canals compared with those elsewhere, that within the alluvial tract are to be found all the great canal systems of India.

26. But the flatness of the surface, which lends itself so readily to the construction of canals, is an obvious obstacle to the construction of reservoirs for the storage of water. Thus, within this large tract there is practically no irrigation from artificial tanks, except in some of the rice districts of Bengal where the slightly undulating surface of the country admits of water being stored in shallow tanks to tide the crop over a break in the rains. In parts, however, of the United Provinces, irrigation is extensively practised from water stored in natural depressions.

27. *The crystalline tract.*—This tract is traversed by all the great rivers which rise in the Western Ghats, but, for the most part, their channels are too deep and their gradients too small to admit of their being utilized for irrigation outside of their narrow valleys. Even when the water can be raised to the level required for commanding the country, the broken and uneven surface renders it impossible to construct, at a practicable cost, systems of canals at all comparable in size to the great canals of the alluvial tract.

28. On the central table-land, the rainfall is generally too scanty, and the drainage too rapid, for the accumulation of an abundant supply of water in the

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subsoil. There is no permanent underground flow as in Northern India, and, the supply being usually dependent on mere local percolation, the wells have to be of large diameter. Their large size and the rocky nature of the substratum render their construction more expensive than in the alluvial tract.

29. With the waters of its large rivers generally unavailable, and with its wells at the best affording a costly means of irrigation and one unsuited to rice, the principal irrigated crop, this tract has to depend for its protection mainly upon storage of the local rainfall. For this fortunately the broken and undulating nature of the surface affords good facilities; and the numerous tanks which stud the surface of the country, and collect the rainfall from a large portion of its area, are the chief characteristic of the crystalline and sandstone formations.

30. *The Deccan trap.*—Within the area covered by the Deccan trap formation, the general configuration of the country is somewhat similar to that of the crystalline tract, but it is even more broken by numerous hills and ranges of hills. The Nerbudda and Tapti rivers have their sources within this tract, and leave it only as they approach the sea. The Godavari traverses it in the first four hundred, and the Kistna in the first two hundred miles of its course. The moisture retaining properties of the soil and the impervious nature of the subsoil cause the local streams to be of a more perennial nature than those in the crystalline and alluvial tracts; but they also prevent the free flow of surface water into the subsoil. Thus, except in some favoured localities the wells are deeper and yield a less copious supply than those of the othe two tracts, while the numerous cracks which form as the soil contracts in the heat of the sun necessitate a frequent or a very copious application of water to an irrigated crop. On the other hand, the soil retains sufficient moisture in all ordinary years to bring the staple crops to maturity without aid from irrigation. In this tract, therefore, there are comparatively few irrigation works of any kind, and irrigation is confined for the most part to the more valuable crops.

31. *Comparative extent of irrigation in the three tracts.*—These differences in the facilities for irrigation in the three tracts have led naturally to corresponding differences in the relative areas protected by the various means of irrigation. This is clearly exhibited in the following tabular statement. The figures given are for areas for which there are fairly reliable statistics, including Native States:—

Division or tract.	Area annually cropped.	Percentage of cropped area irrigated from				
	Thousands of acres.	Canals.	Tanks.	Wells.	Other sources.	Total.
Alluvial . . .	135,000	12·4	1·8	7·3	3·6	25·1
Crystalline . .	100,000	1·5	7·3	4·2	2·5	15·5
Deccan trap . .	58,000	0·2	0·3	2·4	0·3	3·2
Total .	293,000	6·3	3·3	5·3	2·6	17·5

32. Evidently the alluvial tract is, as we have stated, specially favoured by its facilities for canals and wells; for in it lie all but an insignificant portion of the canal area, and about two-thirds of the well area. On the other hand, there is but little tank irrigation, the small area shown under that source being watered chiefly from natural depressions. The crystalline tract contains nearly all the irrigation from artificial tanks. It has practically no canal irrigation, and much less well irrigation than the alluvial tract. In the trap area, where, speaking generally, irrigation is least required and most difficult to provide, there are practically no canals or tanks, and the area watered by wells is inconsiderable.

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SECTION III.—DEVELOPMENT AND PRESENT EXTENT OF IRRIGATION IN INDIA.

33. *Definition of irrigation works.*—The surplus rainfall becomes available for use in artificial irrigation when it accumulates or flows, either upon the surface or in the subsoil, at a level sufficiently high to admit of its being diverted or raised on to the land. But in all cases before this can be done certain works of construction are necessary. These are called works of irrigation, or, briefly, 'irrigation works.' Thus the term irrigation works includes works of many varieties and magnitudes, ranging from the rude contrivances which enable the cultivator by swinging a basket to raise water from a pond, to the huge embankment of earth or masonry holding behind it a lake of many square miles; or from the small temporary well, a mere hole in the ground lined with brushwood, to the great canal which, carrying for some hundreds of miles a volume of water equal to that of a large sized river, delivers it into a network of smaller channels for the irrigation of over a million of acres.

34. *Classes of irrigation works.*—The irrigation works of India may be divided into three main classes: canals, tanks, and wells. Under 'canals' are classed all works of any considerable size for diverting the waters of streams or rivers, and carrying them on to the land; under 'tanks,' all works for the storage of water, and all natural depressions of which the water is used for irrigation; and under 'wells,' works for giving access to the subterranean supply, or to the waters of rivers which, running deep below the general level of the ground, have to be lifted vertically before they can be made to flow on to the fields. Canals are of the 'perennial' or 'inundation' type according as they are designed to draw their supplies from the river at all seasons of the year, or only when it is in flood. In the former case it is almost always necessary to make a weir, temporary or permanent, across the river so as to divert the water into the canal, and this is often one of the most expensive parts of the canal works. Inundation canals have no such weirs. Once cleared of silt they go on taking in water from the river until, at the close of the flood season, its surface falls below a certain level, and the canals then remain dry until the next flood season.

35. *Distinction between State and private works.*—In the case of large tanks or canals, works have to be made and subsequently maintained which are beyond both the means and management of individuals or village communities. Such works are therefore generally constructed and controlled by the State; and we have thus a second classification of irrigation works into 'State works' and 'private works.' All works which have been constructed or which are maintained or partially maintained by the State, are classed as 'State works.' The irrigation from 'private works' is entered in the annual statistics of areas irrigated under the heads of canals, tanks, wells, and 'other sources;' the last including irrigation from rivers and streams, and from channels which are too small to be classed as canals. The distinction between canals and the smaller channels is nowhere clearly defined, and the classification adopted varies from province to province and even from district to district.

36. *Early history of irrigation works in India.*—In the early records of the peoples of India, dating back to many centuries before the commencement of our era, there are frequent references to the practice of irrigation. Wells have been in use from time immemorial; most of the almost innumerable tanks of Southern India have been in existence for many generations—two in the Chingleput district of Madras, which still irrigate annually from two to four thousand acres, are referred to in inscriptions which are said to be of the 8th and 9th centuries of our era; the practice of drawing off the flood waters of the Indus and its tributaries by means of small inundation canals has been followed from a very early date; and in the submontane districts of Northern India are still to be found the remains of ancient irrigating channels which have been buried for centuries in the undergrowth of the forests. But the numerous large works which now exist for utilizing the supplies of the larger rivers are of comparatively recent date; and little seems to have been done in this direction before the country came under British rule. The most notable exceptions are

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the 'Grand Anicut' across the Coleroon river in Madras, some of the inundation canals on the Indus and its tributaries, and two canals taking out of the Jumna river at a point where, passing through a gorge in the outer ranges of the Himalayas, it debouches on to the plains.

37. To the 'Grand Anicut,' tradition assigns a period corresponding to the close of the second century, though it is probably of a much later date. This work is, so far as is known, the greatest engineering work carried out in India before British rule began. It consisted of a solid mass of rough stones, over 1,000 feet in length, 40 to 60 feet in breadth, and 15 to 18 feet in depth, stretching across the whole width of the Cauvery river. It fulfilled its purposes for some centuries, and in 1830 was still in operation, but the vagaries of the river had not been watched, and by that time the main stream had begun to flow down a northern channel known as the Coleroon, and the district of Tanjore had lost much of its former prosperity.

38. Most of the existing inundation canals in the Multan, Muzaffargarh, and Dera Ghazi Khan districts, were constructed by the former Muhammadan and Sikh rulers, and on many of these canals a high degree of efficiency was attained under the management of the great and energetic canal maker, Diwan Sawan Mal.

39. A canal, known as the Hasli, was also constructed by the Sikh or Muhammadan rulers of the Punjab to carry water to Lahore from a point on the Ravi river at a distance of 130 miles. When the Punjab came under British rule, the area irrigated by the canal was paying a revenue of eighty-five thousand rupees. Its general alignment was fairly good, but in detail there had been so many errors that to rectify them would have cost more than making an entirely new channel. The Hasli has been replaced by the Bari Doab Canal, which has more than twenty times its carrying capacity, and is one of the most important irrigation works in India.

40. Owing to the proximity of the Jumna to Delhi, the Muhammadan rulers of India turned their attention at an early period to utilizing the waters of that river for the irrigation of the higher lands on both banks. In the fourteenth century, Firoz Shah Tughlak constructed a canal taking water from the right or western bank of the Jumna, a distance of about 150 miles, to irrigate his favourite hunting grounds at Hissar. This canal, which had silted up, was repaired during Akbar's reign by the Governor of Delhi for the irrigation of lands in his private estate, but for want of repairs it again stopped flowing. About the year 1647 A.D., the canal was repaired under the direction of Ali Mardan Khan, the celebrated Engineer of Shah Jahan, and a new channel excavated to carry water into the city of Delhi. During the decline of the Mughal empire the canal again gradually silted up until it ceased to flow. The canal on the eastern bank of the Jumna was also constructed during the Mughal Dynasty, probably during the reign of Muhammad Shah (1718-1748); but it appears to have been very soon abandoned, if indeed it had ever been used for the carriage of water. In 1784 the work was partially restored by a Rohilla Chief who succeeded in bringing water to some short distance below Saharanpur, and there are traditions of serious injury having been caused thereby to the towns of Saharanpur and Behut. No masonry works of any kind were constructed in connection with the canal; and in their absence, owing to the excessive slope of the country, if any considerable volume of water had been allowed to enter the channel, it must have led in time to a fatal retrogression of bed-levels.

41. Doubts have been expressed as to whether these works, in their former condition, ever irrigated any considerable areas or conferred much benefit upon the people. Be this as it may, it is certain that it was the existence of the 'Grand Anicut' in Madras, and the remains of the old Muhammadan channels in the Punjab and United Provinces, which suggested and led to the construction of the earliest works carried out under British rule. India, therefore, in a great measure owes to her former rulers the first inception of her present unrivalled systems of State irrigation works. The most efficient and useful works which were constructed in former times are, however, the smaller works—

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tanks, weirs, and river-channels—which are to be found scattered throughout the Peninsula, and in Upper Burma. They are most numerous in the Madras Presidency, where to this day they irrigate collectively an area equal to that irrigated by all the larger works which have been constructed by the British Government in that Presidency.

42. *Early development of State irrigation works under British rule.*—With the early history of the construction of irrigation works by the British Government, two names must always be inseparably associated. Those of Sir Arthur Cotton and Sir Proby Cautley—the former in Southern, and the latter in Northern India. In 1836, Sir Arthur Cotton constructed what is known as the 'Upper Anicut' across the Coleroon river, so as to maintain the level required for the full utilization of the ancient dam or 'Grand Anicut' across the Cauvery, which he also strengthened and restored. To this work carried out at a cost of about 15 lakhs, the district of Tanjore, which pays annually to the State a revenue of 58¾ lakhs, owes its present agricultural prosperity. Subsequently Sir Arthur Cotton designed the works which, constructed and improved at a cost of about three crores, irrigate more than two million acres in the Godavari and Kistna Deltas. It would be difficult to find in any country three works of similar magnitude or cost which have conferred the same degree of benefit upon the people and the State.

43. In Northern India, at a still earlier date, during the administration of the Marquis of Hastings (1814-1823), the canal of Ali Mardan Khan, on the western bank of the Jumna, was restored, and the work of reconstructing the eastern canal was put in hand. Subsequently, in 1837, Captain Cautley, an Artillery Officer quartered at Dehra, a town which from some time in the seventeenth century had been supplied with drinking water by means of a small canal from the Rispana river, was deputed to make an estimate of the cost of a small canal from the Tons, a tributary of the Jumna. Here, and subsequently on the Eastern Jumna Canal, Captain Cautley gained the knowledge and experience which he afterwards utilized to such wonderful effect in the construction of the great Ganges Canal—a work which in magnitude and boldness of design has not been surpassed by any irrigation work in India or elsewhere. By the construction of this work was laid the foundation of the numerous large canal systems which now carry their waters so widely over the plains of North-Western India.

44. *Cultivated and irrigated areas.*—The present state of development of Government and private irrigation works will be described in subsequent chapters of this report. It will, however, be convenient to show here the total areas irrigated in the various provinces, and by works of all kinds. The area irrigated in each province is shown in the following statement, and is compared with the total area, the population, and area annually under crop. The areas sown and irrigated are gross areas; that is, areas which are twice sown, or twice irrigated, are included twice over. For Bengal, accurate statistics are not available, and the areas entered as sown and irrigated are based upon an estimate supplied by the Director of Agriculture:—

Provinces.	Area in square miles.	Population.	Average area annually sown.	Area ordinarily irrigated.	Percentage of irrigation on area sown.
			Acres.	Acres.	
Punjab	114,000	22,357,000	28,207,000	10,430,000	37·0
Bombay	76,000	14,529,000	24,327,000	1,077,000	4·4
Sind	47,000	3,211,000	3,323,000	2,923,000	88·0
Madras	142,000	37,690,000	36,574,000	10,532 000	28·8
Central Provinces	87,000	9,877,000	16,814,000	700,000	4·2
Bengal	151,000	73,047,000	63,664,000	6,349,000	10·0
United Provinces	107,000	47,692,000	41,086,000	11,055,000	26·9
Upper Burma	87,000	3,846,000	4,666,000	828,000	17·7
Baluchistan	22,000	308,000	...	5,000	...
Ajmer-Merwara	3,000	477,000	388,000	142,000	36·6
Berar	18,000	2,754,000	6,820,000	56,000	·8
Coorg	2,000	181,000	195,000	1,000	·5
TOTAL	856,000	215,969,000	226,065,000	44,098,000	19·5

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45. The figures show that out of 226 million acres annually under crop in the irrigating provinces of British India, in round numbers 44 million acres, or 19½ per cent., are ordinarily irrigated. The areas in the various provinces are, however, liable to considerable fluctuations. Thus in the United Provinces, with a good monsoon followed by good winter rain, the area irrigated by works of all kinds may fall to under six and-a-half million acres; while in a dry year it rises to over twelve millions. On the other hand, a drought reduces the supply available from tanks in all parts of India, and there is a corresponding reduction in the area irrigated by this class of works. Similarly in Southern, and in some parts of Northern India, a prolonged drought greatly reduces the area irrigated from wells.

46. *Areas irrigated by State and private works of all kinds.*—The following statement shows the areas irrigated by each class of works, both State and private; and the percentage which the area under each class bears to the whole irrigated area:—

Class of work.	Area irrigated by each class of works.	Percentage of total irrigated area.
State works.	Acres.	
Canals	15,644,000	35·5
Tanks	2,944,000	6·7
TOTAL	18,588,000	42·2
Private works.		
Canals	1,235,000	2·8
Tanks	5,194,000	11·8
Wells	12,895,000	29·2
Other sources	6,186,000	14·0
TOTAL	25,510,000	57·8
GRAND TOTAL	44,098,000	100·0

Of the total area irrigated, 18½ million acres or 42 per cent. is watered by State works, and 25½ million acres or 58 per cent. from private works. Of the latter rather more than one-half is from wells. The area shown 'under other sources' of private works includes a large area (5,000,000 acres) irrigated in Bengal from private canals and from water held up in natural depressions and in shallow artificial tanks.

47. *Increase in irrigated area during the past 25 years.*—In the statement given on page 86 of the Report of the Famine Commission of 1878-80, the area ordinarily irrigated in British Territory in a favourable year is said to have amounted to 29,220,000 acres or 14·8 per cent. of the 'cultivated area.' It is not easy to understand how the figures for some of the provinces were arrived at, and certainly in the case of the United Provinces the irrigated area appears to have been considerably overestimated. In those provinces, during the past 28 years, there has been an increase of 1½ million acres in the areas irrigated by Government works, and of at least ¾ million acres in the area irrigated by wells. The area irrigated in a favourable year should, therefore, have risen from 11½ to 13¾ million acres, but in the most favourable recent year the area did not exceed 12¼ million acres. Twenty-five years ago the statistics of areas irrigated by private works were not sufficiently accurate in many of the provinces to admit of reliable estimates being framed. It seems useless therefore to compare our figures with those given by the Famine Commission. There are, however, accurate statistics which show that during the past 25 years the area irrigated by Government works has been increased by 8 million acres, or by eighty per cent.; and from an examination of such records as are

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available, we have no doubt that within the same period the area irrigated by private works has been increased by at least three million acres. There has therefore been within the past 25 years a total increase of not less than 11 million acres, or of 33 per cent., in the area irrigated in British territory.

48. *Irrigation in Native States.*—For the more important Native States, excluding those of Burma and Baluchistan, it has been possible to obtain what appear to be fairly correct statistics of the irrigated areas. In the case of some of the smaller States the correctness of the figures supplied to us is open to doubt. In the following statement we summarize the information which has been furnished to us:—

State or administration.	Area to which statistics refer.	Population.	Average area annually sown.	Area irrigated in an ordinary year.	Percentage of cultivation under irrigation.
	Square miles.		Acres.	Acres.	
Baroda	8,000	1,953,000	2,550,000	184,000	7·2
Hyderabad . . .	83,000	11,141,000	16,000,000	772,000	4·8
Mysore	28.000	5,449,000	6,132,000	945,000	15·4
Central India . .	69,000	5,920,000	10,668,000	595,000	5·6
Rajputana Agency . .	113,000	8,475,000	6,491,000	1,172,000	18·1
Madras States . . .	9,000	4,144,000	1,090,000	625,000	57·3
Bombay States . . .	60,000	7,254,000	20,131,000	963,000	4·8
Bengal States . . .	7,000	877,000	1,237,000	353,000	28·5
United Provinces States .	1,000	533,000	402,000	39,000	9·7
Punjab States . . .	35,000	4,220,000	4,225,000	1,958,000	46·3
Central Provinces States .	25,000	1,360,000	2,150,000	157,000	7·3
TOTAL .	438,000	51,326,000	71,076,000	7,763,000	10·9

49. *Total irrigation in the Indian Empire.*—A number of States in which there is little or no irrigation have been omitted from the statement above; besides many smaller States for which no information is available. Most of these latter are, however, situated in Bengal or in hilly tracts, and the irrigated area within them must be inconsiderable. From the figures for some of the States the areas of *jagir*, or alienated, lands are excluded. Making an allowance for this, and for the States from which no returns have been received, the total area irrigated annually within the Indian Empire, excluding the Native States of Burma and Baluchistan, is estimated at about 53 million acres. Of this area 19 million acres are irrigated from canals, 16 million from wells, 10 million from tanks, and 8 million from other sources.

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Chapter II.—THE LIMITATIONS OF IRRIGATION.

50. *Small percentage of rainfall now utilized in irrigation.*—The data required for determining the extent to which the rain-water is utilized for irrigation, are in many respects incomplete. The actual volume of the rain which falls annually over the greater part of the country, can be ascertained with a near approach to accuracy from the very complete data published by the Meteorological Department. But for determining with scientific exactness the proportion of the rainfall which flows off the ground surface, and which might be made available for canals or for storage, the necessary information is not available for many of the most important river-basins. For the Godavari, Kistna, Cauvery, Penner, Palar, and Ponniar, there are records of the surplus flow, from the greater part of the catchment, extending back for a sufficient number of years to admit of a fairly accurate estimate being framed of the average flow; and in the case of the Indus the detailed observations made during recent years by the Indus River Commission are of material assistance. For the Ganges also the daily gauge readings at Benares, and the few observations which have been made of the flow in the river, afford material for a rough estimate of the average flow past that place; and for the Mahanadi records are available of the daily discharge throughout one recent year. But for the Ganges below Benares, for the Nerbudda, Tapti, and Subarnrekha, there are no records to show the surplus passing to the sea. In these cases reliance must be placed upon a co-efficient of run off, selected with regard to the rainfall and other conditions, and to the co-efficient of actual flow determined for other catchments. The estimates arrived at by this method must be regarded as mere rough approximations. There are, moreover, no records to show what percentage of the volume used for irrigation is restored to the rivers by percolation through the subsoil or otherwise. It is, however, probably very much less than is indicated by observations made in America, and for our purposes it will be sufficiently correct to assume that the total surface flow is made up of the volume passing to the sea *plus* that utilized for irrigation. Nor are the records of the volumes used in irrigation always procurable; but for most of the larger and for many of the smaller works, accurate records are kept of the volumes entering the main channels. Figures can, therefore, be arrived at, which, as a whole, will exhibit fairly correct results.

51. In the accompanying diagram we show, with as near an approach to accuracy as seems possible with the data at present available, the total volume of rainfall over the catchments of the principal rivers or groups of rivers, the resulting surface flow, and the extent to which that flow is utilized in irrigation. The area included in our estimate comprises the basins of the Indus and Ganges, and the rest of India which lies between their southern boundaries and Cape Comorin; the catchment basins of the Brahmaputra, and of the Irrawadi and other Burmese rivers, and all that part of Baluchistan which lies westward of the Indus watershed being excluded from the calculation. Over this area, covering 1,434,000 square miles, the average annual rainfall is $37\frac{1}{2}$ inches, giving a total volume of 125 billion cubic feet of water. Of this, a volume of 51 billion cubic feet, or 41 per cent., results in surface flow; and of this again $6\frac{3}{4}$ billion cubic feet is held back or diverted for purposes of irrigation. Of the water which is thus held back or diverted, only a proportion, certainly not more than 50 per cent., is actually delivered on to the fields. But if the whole volume were to reach the fields, it would represent a depth of $3\frac{3}{4}$ feet over the total area of 40 million acres which, making a rough allowance for areas watered by river floods, may be taken as the area irrigated from all sources except wells. The depth varies from about $2\frac{3}{4}$ feet in Northern India, where the irrigation is chiefly that of *rabi* crops from canals and natural depressions, to 5 feet or more on the rice fields of Southern India.

52. Of the 59 per cent. of the rainfall which remains to sustain plant life, to evaporate into the atmosphere, to moisten or saturate the soil, or to replenish the waters of the subsoil, a small percentage is drawn off through wells and

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utilized for irrigation. There are very few data available for estimating this percentage with any pretence to accuracy. But in Northern India, where three-fourths of the well irrigated area is to be found, the aggregate depth of the waterings given to each crop does not, on the average, exceed a foot in depth. In Southern India, where sugarcane and garden crops constitute a large proportion of the area watered from wells, the total depth of the waterings may be taken at two and-a-half feet. At a rough estimate, therefore, one billion cubic feet, or 0·8 per cent. of the rainfall, is utilized in well irrigation.

53. Thus, roughly, it may be said that, out of a total rainfall averaging 37½ inches in depth, 59 per cent., or 22 inches, is absorbed in sustaining plant life, in maintaining moisture in the soil, and in replenishing the subsoil water-supply, or is lost by evaporation; 6 per cent., or 2¼ inches, is utilized in artificial irrigation of all kinds; while the balance of 35 per cent., or 13¼ inches, is carried away by the rivers. Again, according to our calculations the surface flow amounts to 51 billion cubic feet, and of this only 6¾ billion cubic feet, or 13 per cent., is utilized in irrigation. The balance of 44¼ billion cubic feet, or 87 per cent. of the total surface flow, passes to waste in the sea.

54. By those who have no knowledge or only an incomplete knowledge of local conditions, it may be thought that a large part of the great volume of water, amounting to more than 44 billion cubic feet, which now passes uselessly to the sea, might have been utilized, or could be utilized in the near future, for an enormous extension of irrigation and the effectual prevention of famine. We have seen that, although there are extraordinary local variations of the rainfall, the total amount received over the whole of the Indian Peninsula does not vary very appreciably from year to year. Why then, it may be asked, should it not be possible to utilize the surplus of one tract to make up the deficiency of another; or, where the physical conditions render this impossible, why should not the surplus of wet years be stored up in readiness for a year of drought in every tract of which the rainfall is liable to failure? We are, as we shall presently show, far from considering that irrigation in India has reached its ultimate limit. We cannot state, as the result of our inquiries, exactly what that limit may be; but we are convinced that there are many parts of India where the utmost use of every available means of irrigation will fail to afford complete protection against failure of the rainfall. It seems necessary, therefore, to state a few facts and considerations in order to dispel any erroneous impressions that may have arisen from a study of the figures which we have given, and to prevent over-sanguine expectations being raised as to the possibility of utilizing in irrigation any very large share of the enormous surplus volumes which our calculation shows to be carried off annually by the rivers of India.

55. *Conditions limiting the extension of irrigation.*—The main conditions imposing a limit to the use which can be made of the surplus drainage of the country for the prevention of famine are:—

(1) the geographical and seasonal distribution of the rainfall;
(2) the physical configuration of the country;
(3) the difficulty of holding up water stored in years of good rainfall as a provision against a year of drought;
(4) the character of the soil; and
(5) the large number of different States and territories into which the country is divided and sub-divided.

56. *Limitations imposed by the distribution of the rainfall.*—In its geographical distribution, the rainfall displays a diversity which is said to be without parallel in any other country in the world; the average annual fall varying in different localities from under five to nearly five hundred inches. Leaving mere questions of distance and cost out of consideration, the general contour levels of the country will frequently offer an insuperable obstacle to the transfer of water from regions of copious and assured rainfall to those where it is scanty and capri-

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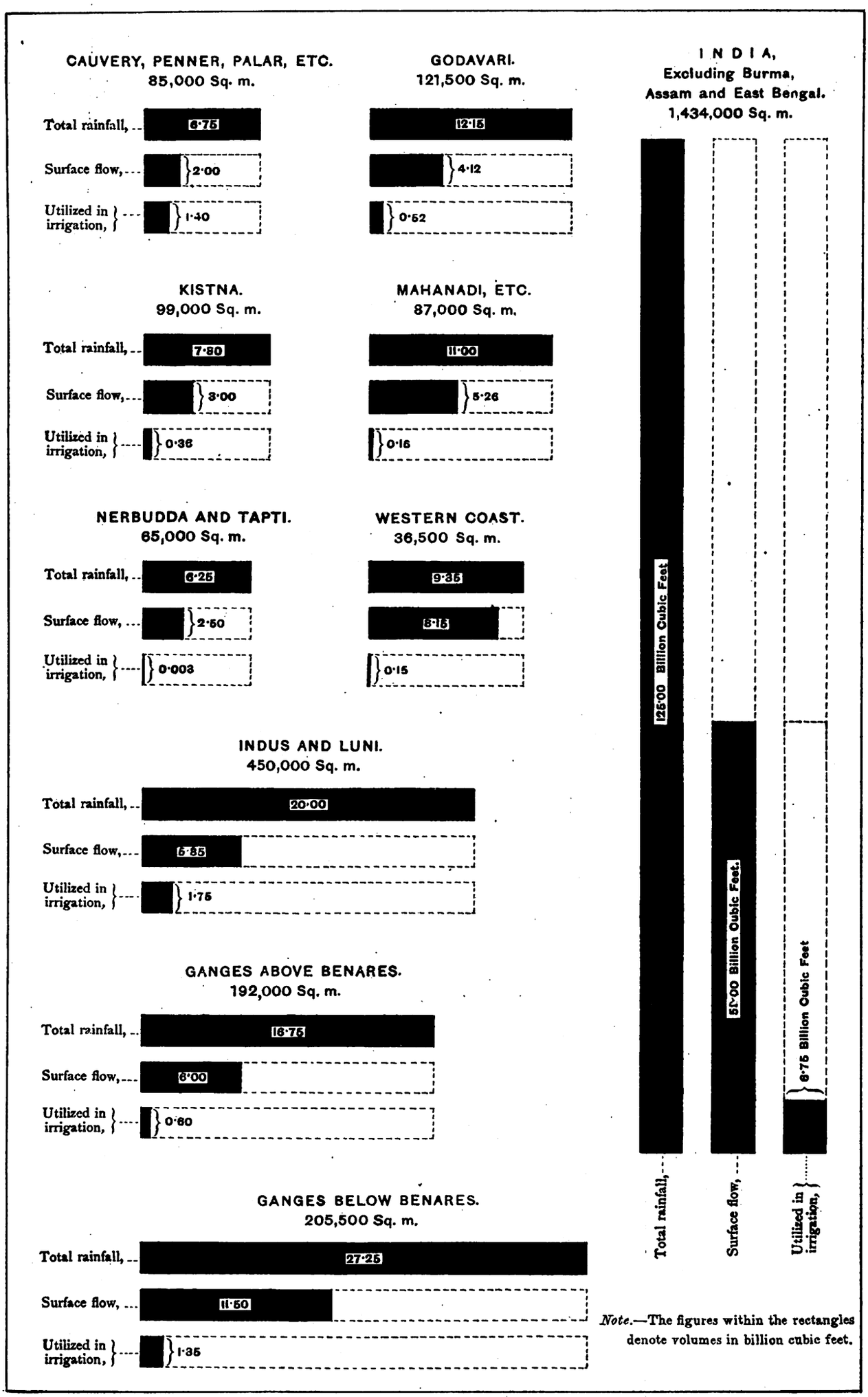

DIAGRAM COMPARING THE VOLUMES OF RAINFALL, SURFACE-FLOW, AND PORTION OF SURFACE-FLOW UTILIZED FOR IRRIGATION, IN THE RIVER-BASINS OF INDIA, EXCLUDING BURMA, ASSAM AND EASTERN BENGAL.

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cious. At the same time, the seasonal distribution of the rainfall, which is confined for the most part to a few months of the year, presents a condition most unfavourable to its economical storage and use; for if the water is to do more than merely tide the autumn crop over breaks in the monsoon, the storage reservoir must be made large enough to carry the subsequent crop to maturity by means of the volume stored in a single rainy season. Over the greater part of the country, there is little or no chance of subsequent rain refilling the reservoir after its water has been partially utilized.

57. *Difficulties connected with the surface conformation.*—The general conformation of the surface adds still further to the difficulty and cost of storage. On the flat surface of the alluvial plains of Northern India, storage on any considerable scale is, as we have said, almost impossible. If we allow for evaporation and percolation, it involves generally the submersion of an area at least as large as that which would receive benefit from the water. There are no doubt portions of these plains in which water is held up by embankments during the rainy season so as to moisten the lands above and prepare them for the autumn sowings. But this can hardly be designated storage in the proper sense of the word; and the system is adopted only when the rainfall is especially liable to failure, and the population so scanty that the loss of the submerged land for the growth of the *kharif* crop becomes a matter of secondary consideration.

58. On the other hand, in the Western Ghats, where the assured rainfall might be stored at a sufficient elevation to admit of its being carried into tracts where the rainfall is scanty and peculiarly liable to failure, the steep slopes of the valleys necessitate, as a rule, the construction of a dam at least one hundred feet in height, if water is to be stored in any considerable volume; and for this, sound foundations and suitable materials within a reasonable distance are essential. Again, if these are procurable, the site must be such that the length of the dam shall not make the cost prohibitive in proportion to the volume stored; and when all these advantages have been secured, the construction of the work may involve the submergence of many thousand acres of what are generally the most fertile lands, or even the removal of whole towns or villages. The future safety of the work will depend upon adequate provision being made for the discharge of flood water during cyclonic storms, and this, in many otherwise excellent sites, can only be arranged for at an enormous outlay. Finally, the construction of the necessary works for carrying the supply across the rough and broken surface of the country to the area requiring irrigation, may involve the most serious difficulties, and necessitate the rejection of a site that would be suitable in all other respects. Many of these difficulties could, no doubt, be disposed of, if no regard were paid to the cost. But, even where the object is prevention of famine, there is a limit to the expenditure which the general community can be expected to incur for the benefit of a particular tract.

59. *Impossibility of conserving water for a year of drought.*—With regard to storing the rainfall of good years for use in a year of drought, we may say that if there is one point upon which our inquiries have convinced us, it is that where, as in many parts of India, the only possible source of supply is an uncertain and often insufficient rainfall, it will not be possible to provide, at any practicable cost, the amount of storage required to counteract the effects of severe and prolonged drought. There are no means of predicting a year of drought, and any attempt to hold over water, even from one year to the next, would entail the loss of an enormous proportion of the supply by evaporation and percolation. In these circumstances it would obviously be bad economy, and fatal even from a purely protective point of view, to limit the cultivation under a tank, and to refuse to give out water to the cultivators, which they could utilize advantageously from year to year, in order to hold it up as an insurance against a possible drought. The drought might come next year; but on the other hand it might not come for five or even ten years, and meanwhile the cultivators would have been deprived of all the benefits which they might have derived from the annual use of at least twice the quantity of water that could be held over for the year of drought. Moreover, famine is not usually the result of one dry year. The

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worst famines have been the result of two or even three dry years in succession; and whatever might be the possibility of holding over water for the first dry year, to do so for the second or third would be entirely out of the question.

60. *Unsuitability of soil.*—We have already referred to the general unsuitability to irrigation of the black cotton soils which cover such a large portion of the area of India. In addition there are large areas of inferior sandy or stony soils which would never repay the cost of artificial watering. And, we may add, there are enormous areas of forest and uncultivable waste, where water cannot be used, however great the facilities for providing it. In British territories alone, in the area under consideration, the forests cover an area of more than eighty thousand square miles, or eleven per cent. of the surface; and there is nearly twice that area of uncultivable waste. About one hundred and twelve thousand square miles are said to consist of lands fit for cultivation which are now lying waste, but a very considerable proportion of this has a soil too poor to repay the cost of cultivation.

61. *Territorial difficulties.*—The numberless territorial divisions of the country, and the manner in which the various States and territories are intermingled, have also been a material obstacle in the past to the development of irrigation. The only suitable site for a storage work may lie in a territory whose people would not only derive no benefit, but might even be put to considerable loss and inconvenience, by the construction of the work; or the full utilization of an available supply may only be possible by the co-operation of two or more States who are unwilling to combine. We have found numerous instances in which these and other territorial considerations have offered in the past a serious hindrance to the construction of irrigation works; but we believe that in the settled condition of the country, these difficulties will be found capable of adjustment by friendly co-operation of the States concerned with each other and with the Supreme Government.

62. *Limiting effects of the conditions in certain river basins.*—The general effect of each or all of these obstacles in retarding or hindering the utilization of the surface drainage in the development of irrigation, will best be exemplified by a brief survey of the general conditions in the catchments of some of the principal rivers.

63. The Palar river in the Madras Presidency affords an excellent instance of the extent to which, under favourable conditions, the surface waters can be stored or diverted on to the land; and yet of their inadequacy under certain conditions to afford full protection against drought, even when supplemented by a fair share of well irrigation. Within this catchment the surface conformation is generally favourable to the construction of tanks; and the rainfall, due to both monsoons, is spread over seven or eight months of the year, so that in ordinary years the tanks are frequently refilled after a portion of the supply has been drawn off for irrigation. To such an extent have these facilities been utilized that in most years there is but little surplus flow from the basin of this river. Almost the whole of the available rainfall from an area of nearly 9,000 square miles, lying in this and the adjoining minor river-basins, is stored in tanks or diverted into canal channels. And yet the Madras districts of North Arcot and Chingleput, and the eastern portion of the Kolar district of Mysore, which lie in this area, are liable to suffer periodically from scarcity or famine. They have suffered severely from failure of the rainfall as recently as in 1891 and 1896, although in both of those years practically no water was allowed to run to waste. Nor can it be said that water could have been stored from the surplus of the preceding years; for, if the small surplus volume of each of those years had been stored, it could have had no appreciable effect in increasing the area under irrigation.

64. South of the Palar lie the basins of the Ponniar and Cauvery rivers, in each of which nearly 60 per cent. of the surplus flow is used in irrigation. To proposals for drawing off further supplies from the Ponniar catchment, the French Government have raised objections on the ground of possible reductions

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in the supplies now available for their existing irrigation works in Pondicherry. In the case of the Cauvery, of which one-third of the total catchment of 31,000 square miles lies in the Native State of Mysore, the main obstacle to the further utilization of the surplus flow resulting from an average rainfall of 38 inches, lies in the fact that, throughout the upper part of its course, the river flows through a deep and wide valley at right angles to the general direction of the drainage from the Western Ghats on its right bank. It thus cuts off all this drainage from the dry tract on its left bank where the water would be of the greatest value. This tract therefore is dependent for its irrigation upon a local rainfall which, though usually sufficient, has sometimes failed. When, as in 1875-76, the drought is prolonged, the tanks and all local sources of irrigation must, as we have shown, fail to afford full protection to cultivation.

65. Selecting now an instance from the more central portion of the peninsula, we find that in the basin of the Godavari 12½ per cent. of the flow from a catchment of 121,500 square miles, with an average rainfall of 43 inches, is used in irrigation. But of the volume thus utilized 33 per cent. is accounted for in an area of under 2,000 square miles where, near the mouth of the river, the flat surface of the delta affords excellent facilities for the irrigation of the greater part of its area. Only 8 per cent. of the total flow is utilized in the rest of the catchment, while the balance of 87½ per cent., or more than 3½ billion cubic feet, passes away in floods, chiefly during the short period of the south-west monsoon. A small percentage of the surplus can be utilized in the Bombay Deccan if storage works are constructed, as we have recommended, on the main river, or on the Mula, or at Maladevi on the Pravara; a little more could be utilized in the valley of the Wainganga tributary, a comparatively small tract in which until recently the rainfall has never seriously failed; and small works may be proposed in the upper part of the Godavari district in Madras. There is little scope, elsewhere in British territory, for the further utilization of the surplus flow. Nearly one-half of the whole basin lies in the territories of Native States; and of the area in British territory over a third consists of black soils which are generally unsuited to irrigation.

66. In the adjoining basin of the Krishna, or Kistna, river there is an average rainfall of 34 inches, of which 38 per cent., or a volume of 3 billion cubic feet, results in surface flow. Of this only 355,000 million cubic feet or 12 per cent. is now utilized in irrigation. Within this catchment lies a larger extent of exceptionally insecure country than is to be found in any other river basin in India, and within a hundred miles or less of a great part of that area stretches a long strip of hilly country within the region of the assured rainfall of the Western Ghats. We have already referred to the obstacles which interfere with the full utilization of this abundant and certain supply. But we are hopeful that within the next twenty years it will be found possible to store or divert sufficient water for the irrigation of a considerable area in the insecure Deccan districts of Bombay. There are also possibilities of irrigating a very large area in the equally insecure Deccan districts of Madras, and in the adjoining district of Nellore. In Mysore, the great Marikanave tank will afford the means of storing 30,000 million cubic feet—a volume but little short of that held up by the great Nile reservoir at Assuan; and there are, in addition, a number of minor schemes proposed for the utilization of the supplies of the smaller rivers or for the storage of local rainfall. This river basin will therefore be the great field of operations for the construction of protective irrigation works during the next twenty or thirty years. But if every project that has been proposed by us or brought to our notice is pushed to completion, the result will be to effect a reduction of not more than two-thirds of a billion cubic feet, or of about one-fourth, in the volume now running to waste. Sixty-five per cent. of the total surface flow will still pass to the sea.

67. In Orissa, the Mahanadi, Brahmani, and Subarnrekha, carry annually to the sea more than 5 billion cubic feet or 97 per cent. of the water which flows on their catchments. With a fairly steady rainfall which averages over 54 inches, and which falls below 50 inches only in one small tract, there is but little demand or necessity for irrigation over the greater part of the basins of these rivers.

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68. To the west of the Mahanadi, and flowing westward, the Nerbudda and Tapti carry into the Arabian Sea 99·9 per cent., or practically all, of the surface drainage from an area of 65,000 square miles. The prevalence of black cotton soil throughout almost the whole of the catchments of these rivers accounts for the infinitesimal percentage of water utilized. We do not despair of the possibility of making some use of the water in certain tracts of suitable soil, but at the best there will be held back from the sea only a mere fraction of the $2\frac{1}{2}$ billion cubic feet of the surface drainage of these two river catchments.

69. Finally, before leaving the peninsula and passing to Northern India, we may point to the enormous volume of 8 billion cubic feet, or nearly 16 per cent. of the whole surface flow of India, which annually rushes down to the Arabian Sea from the steep slopes of the Western Ghats. By the bold device of constructing a reservoir at Periyar on the outer slopes of the Ghats, and carrying the water by means of a tunnel through the intervening hill on to the eastern table-land, the Madras Government have been able to utilize about 10,000 million cubic feet or 0·125 per cent. of this flow. The chances of being able to repeat this measure in the Ghats further north do not appear to be promising. No final opinion can be passed upon this point until every possible site has been examined; but there are certainly no prospects of ever making any appreciable reduction in the enormous volume now annually lost along this coast.

70. In Northern India, in the great valley of the Indus river, we find conditions which are on the whole exceptionally suitable for the effective utilization of the surface waters. The snows and glaciers of the Himalayas provide storage on a scale that man cannot hope to rival; the level alluvial plains lend themselves to the economical construction of large canals; while the demand of the thirsty soil for water renders all such works remunerative in the highest degree. And yet, under these exceptionally favourable conditions, only 9 per cent. of the total rainfall, or 30 per cent. of the surface flow, is retained for purposes of artificial irrigation. We have no doubt that, notwithstanding the enormous areas already irrigated in this catchment, amounting if well irrigation be included to 18 million acres, it will be possible to make very large extensions of irrigation by utilizing a portion of the present surplus drainage. But if all the works which are now conceived to be possible in the Punjab and Sind are constructed, although they may absorb an additional half billion cubic feet, not a single large tract that is especially liable to famine will be appreciably affected thereby, and 60 per cent. of the surface water will still run to waste in the sea. No human skill or ingenuity will carry any portion of this volume of $3\frac{1}{2}$ billion cubic feet to the high lying plains of Jaipur and Marwar, or over the ridge of the Indus valley to famine-stricken tracts in other parts of India.

71. In the Ganges Valley, with a more copious rainfall and consequent smaller demand for water, out of 17·5 billion cubic feet of surface flow, only 2 billion, or 9 per cent., is utilized. In the portion of the basin which drains into the river above Benares only 0·6 billion cubic feet is retained, although the waters of the Jumna and Ganges proper are drawn upon to the greatest extent that has been found possible by the highest engineering skill. No means have yet been found for storing any portion of the enormous floods which are brought down from the Himalayas during the few months of the monsoon season. In the outer ranges, where the rainfall is greatest, the steep valleys of the hills, with their deep and porous beds of loose boulders and shingle, hold out small hope of affording any suitable sites for reservoirs; and even if a site could be found and a reservoir constructed, it would, in all human probability, silt up in a very few years. The fine and slowly settling sediment of the Nile or the Betwa can be carried through a reservoir many miles in length, but the coarser materials of hill streams sink to the bottom as soon as their velocity is appreciably checked. On the right bank of the Jumna, in the tract drained by the large tributaries of that river, with their sources in the Vindhyas or the table-land of Central India, more than three-fourths of the catchment lies in the territories of Native States. In the comparatively small tract in British territory there are, no doubt, at least six districts which are peculiarly liable to suffer from drought; and to some of these it will be possible, although at a considerable annual loss to

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the State, to afford a fair measure of protection by storing and utilizing a portion of the supplies of the larger rivers. But there will still remain a number of tracts in which the only sources of irrigation will lie in a deficient and capricious local rainfall. And, even if every measure which might reasonably be contemplated for increasing the area of irrigation in these British districts is carried to completion, the addition to the utilized volume will not exceed 200,000 million cubic feet. Thus more than 85 per cent. of the surface drainage will still flow past Benares.

72. Over the catchment which drains into the river below Benares the rainfall gradually increases towards the north, east, and south, both in amount and certainty, and there is a corresponding reduction in the need for irrigation. There lie, however, within this portion of the catchment many tracts which are to a greater or less extent in need of further protection. But, when in the whole catchment of the Ganges all has been done that can be done, it may safely be asserted that, unless there is a remarkable change in the physical or agricultural conditions, the river will still carry annually to the sea at least 15 billion cubic feet of water. Thus, from this single catchment and from the outer slopes of the Western Ghats, there will still be a loss of over 23 billion cubic feet—a volume which falls but little short of half the total surface flow of India, excluding Burma and Assam.

73. In another chapter we put forward a programme of new irrigation works, which should, if completed, have the effect of increasing the area under irrigation by $6\frac{1}{2}$ million acres. This will involve the subtraction of about one billion cubic feet only, or of less than $2\frac{1}{4}$ per cent. of the surplus volume which now runs to waste in the sea.

74. *Limits to the extension of well-irrigation.*—In the preceding paragraphs we have discussed the limits up to which irrigation from the surface flow of water is capable of extension. There remains the question of the degree to which the subsoil water-supply can be more widely utilized than at present. We have estimated the volume of water expended on irrigation from wells at about one billion cubic feet, or not more than $1\frac{1}{2}$ per cent. of that portion of the rainfall which penetrates the soil. As far as supply is concerned, this percentage might no doubt be more than quadrupled; but the quantity of water in the subsoil can no more be taken as a measure of the possibilities of well irrigation, than the volume of surface flow passing into the sea can be taken as a measure of the possibilities of irrigation by works other than wells. The limitations, however, to which irrigation from wells is subject are no less positive and definite than those of irrigation from the surface flow. The soils and crops which are unsuited to the latter class of irrigation, are generally equally unsuited, and in some cases even less well suited, to the former. Thus on some black soils, even where canal or tank irrigation might prove advantageous, at any rate in a year of drought, well-irrigation very often would not pay, owing to the inordinate expense of raising the large quantities of water required. For the maturing of the rice crops well-irrigation rarely, if ever, pays. But the principal distinctive limitations to the extension of well-irrigation consist in the amount and quality of the subsoil supply, the depth at which it is found below the surface, the conditions of soil and subsoil favouring or impeding construction, and the consequent expense of construction and raising the water. In the alluvial tracts of Northern India, down to the line of the Jumna river, the subsoil supply of good water is practically inexhaustible, and its depth generally moderate; the soil and subsoil also generally favour construction. It is difficult, therefore, here to place any limit to the eventual extension of well-irrigation, except the requirements of cultivation. There are already districts of the Punjab and United Provinces which have all the wells they require. South of the Jumna the water lies deeper, and is less abundant; it is also more liable to exhaustion in times of drought; rock has to be penetrated, and the expense both of construction and lifting is greater. In addition, more numerous waterings are required, the total area irrigated is smaller, and well-irrigation generally does not pay except for a valuable crop. Here the extension of well-irrigation must be exceedingly gradual, and can only increase *pari passu* with a development of the general resources of the people. But while this extension cannot be rapid, it can and doubtless will continue long

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after the extension of irrigation by flow has ceased; and it may not be over-sanguine to look forward to a period when the area under well-irrigation throughout India will have doubled. At the same time, there will always remain extensive tracts, such as the black soil plains and stony uplands of the Deccan trap and crystalline areas, where wells are impossible or will never pay; and which will be protected from famine, by means of irrigation, no better than at present, notwithstanding the utmost development which may be effected in the multiplication of wells.

75. *Conclusions.*—From this brief sketch of the conditions prevailing in a number of the principal river-basins, and of the general conditions imposing a limit to the extension of well-irrigation, it should be evident that in many tracts which are necessarily dependent upon the local rainfall, even the utmost possible use of the available supplies of water will fail to afford complete protection against famine; that the volume of the rainfall, or of the waters which pass unused to the sea or percolate into the subsoil, affords no index to the possibilities of extending irrigation; and that the limits to its further extension are those imposed by the local and other conditions which have here been briefly indicated, and which are discussed in fuller detail in subsequent chapters of this report. But, although there are limitations to the protection that irrigation can be made to afford, the very impossibility of its affording complete protection makes it all the more incumbent to utilize to the utmost such means as exist for its extension.

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CHAPTER III.—STATE IRRIGATION WORKS.

76. *Classes of works.*—The State irrigation works in India consist essentially of two kinds: small works originally constructed by the former rulers of the country or the owners of the soil, and now controlled and maintained by Government; and large works which have been constructed or reconstructed by the British Government as productive or protective public works, or, in other words, as financial investments which were expected to be either directly or indirectly remunerative. The most important, though not all, of the latter are technically classified as 'major works,' while the class 'minor works' includes all of the former and also a few of the latter. The minor works consist for the most part of small local works which are maintained by Government in consideration of the revenue derived from or dependent upon them, but so little capital outlay has been incurred on them by the British Government that capital accounts have not been opened for them. Between works of this kind and major works there is, however, an intermediate class, known as 'minor works for which capital and revenue accounts are kept.' Some of the works in this class are old native works which have been improved or enlarged by Government at a considerable cost; others are new works, generally of small size, which have been constructed by the British Government, but which have not, for reasons which it is unnecessary now to consider, been classed as major works. State irrigation works must, therefore, be considered under three heads :—

(*a*) Major works.

(*b*) Minor works for which capital and revenue accounts are kept.

(*c*) Minor works for which capital accounts are not kept.

MAJOR WORKS.

77. *Financial results.*—The following table exhibits the financial results attained on major works during the year 1900-01, which may be regarded as fairly normal in the aggregate, though not in all cases for individual provinces :—

Province.	Number of works.	Capital outlay to end of 1900-01.	Percentage of net revenue.		Total area irrigated in 1900-01.	Average rates per acre.		
			On total capital outlay.	On gross revenue.		Average value of crops.	Revenue assessed	Working expenses.
		Lakhs of rupees.			Acres.	Rs.	Rs.	Rs.
Punjab	7	10,73·0	10·5	70·0	4,642,852	27·5	3·4	1·1
Sind	5	1,79·3	7·7	76·5	961,434	15·6	1·9	0·4
Bombay	9	1,87·6	1·2	52·2	84,472	77·2	4·8	2·5
Madras	9	7,29·6	8·5	79·6	2,915,271	36·7	4·1	0·9
Bengal	3	6,16·8	0·8	28·8	716,271	34·4	1·9	1·7
United Provinces . .	6	8,77·4	7·3	66·4	1,888,091	39·2	4·3	1·7
TOTAL .	39	36,63·7	7·1	67·8	11,208,391	31·6	3·5	1·1

It will be seen that the works in Bombay (Deccan and Gujerat) and in Bengal do not earn enough revenue to cover the interest charges on capital outlay. Not one of the twelve works in these provinces has proved remunerative, and with the possible exception of the Sone Canals in Bengal, there is no prospect that any of them will ever become so. In all other provinces the works, as a whole, have proved highly remunerative; but there are three works in Madras, and one in the United Provinces, which give no promise of ever fulfilling the conditions of a productive public work. Nevertheless, taking the works for all provinces together it will be seen that regarded merely as a financial investment the works have been very profitable, and now yield a net revenue which is equivalent to a return of 7·1 per cent. on the capital cost, and exceeds the annual interest charges at four per cent. by more than 113 lakhs.

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Some of the works, however, are not yet fully developed, and a higher return than this may be confidently anticipated in the future.

78. *Protective value.*—It would be difficult to overestimate the value to the country of these fine systems of irrigation works, which may be said, with some slight reservation in respect of the Cauvery works in Madras, to have been entirely created by the British Government within the last eighty years. They irrigate annually over 11 million acres, and completely protect from famine an area which, except in the Madras and Orissa deltas, may be said to vary from twice to four times the area annually irrigated. In some parts, as in Sind, there can be no cultivation, and therefore no population, without canal irrigation. In others, the effect of the works in maintaining or raising the level of the subsoil water, on which the well-irrigation depends, is of the utmost value and importance. The value of the crops irrigated by the canals in a single year is about equal to the whole capital cost of the works; and in years of famine the produce of the irrigated area, being largely available for transport to distressed tracts, becomes an important item in the general food supply of the country.

79. *Magnitude of the works.*—Excluding the Cauvery works, which merely regulate the supplies in the river channels of the delta, the combined discharging capacity of the head channels or main lines is over 100,000 cusecs.* The works in Bombay and Madras have also storage reservoirs with a combined storage capacity of over 30,000 million cubic feet, while the total length of Government channels, including main lines, branches, and all distributaries, is about 36,000 miles. It may be added that the table which we have given does not include two important works which were completed and opened in 1901-02, *viz.*, the Jhelum Canal in the Punjab and the Mandalay Canal in Burma. These two works will probably irrigate before long over 700,000 acres.

MINOR WORKS FOR WHICH CAPITAL AND REVENUE ACCOUNTS ARE KEPT.

80. *Character of the works.*—Under this head are included a few small works which have been initiated and carried out by the British Government, but the majority of the works of this class were constructed by former rulers of the country or in their time. They have, however, been enlarged and improved by means of expenditure which has been charged to a capital account, and the works are credited with the increase of revenue which is attributable to that expenditure. In the Punjab and in Sind, minor works consist almost entirely of groups of inundation canals from the Indus or its tributaries, which irrigate very large areas. In other provinces they consist partly of tanks or storage reservoirs, and partly of small canals or groups of canals which generally take off from above weirs built across the smaller streams of the country. There are, in all, seventy-three minor works for which capital accounts have been opened.

81. *Financial results.*—The following table shows the financial results attained on these works during 1900-01 :—

Province.	Number of works.	Capital outlay to end of 1900-01.	Percentage of net revenue in 1900-01 on capital outlay.	Area irrigated.	Rate of revenue assessed per acre.
		Lakhs of rupees.	Per cent.	Area.	Rs.
Punjab	5	25·46	12·8	602,189	1·8
Sind	7	39·84	26·2	882,956	2·3
Bombay	27	74·47	—1·6	39,922	1·7
Madras	24	97·90	5·2	511,603	3·3
Bengal	1	7·06	—0·2	...	...
United Provinces	4	29·70	5·1	113,793	2·3
Rajputana	3	29·49	—0·1	34,767	3·8
Baluchistan	2	16·12	0·8	5,232	6·7
GRAND TOTAL	73	320·04	6·0	2,190,462	2·4

* Throughout this report the word 'cusec' is used for 'cubic foot per second.'

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In Bengal and Bombay these minor works are, it will be seen, even less remunerative than the larger systems; in fact they fail to yield a net revenue sufficient to cover the working expenses. The works in Rajputana and Baluchistan are also unremunerative, but for the former province the results for 1900-01 are distinctly below the average, and in all ordinary years a return of 2 or 3 per cent. is realized. Taking the works as a whole, it will be seen that they yield an average return of 6 per cent. on capital cost, and are almost as profitable to the State as the major works. This result, however, is mainly due to the large returns earned by the inundation canals in Sind and the Punjab.

82. *Protective value and magnitude of the works.*—The works irrigate over 2 millions of acres annually, but the irrigation is more variable and uncertain than that effected from the large works, both inundation canals and tanks being liable to fail in unfavourable seasons. Nevertheless the protective value of these minor works is very great when compared with the capital outlay incurred on them. The total length of the Government channels pertaining to them exceeds 7,000 miles, and there are storage reservoirs with an aggregate capacity of over 25,000 million cubic feet.

Minor works for which capital accounts are not kept.

83. *Nature of the works.*—We have next to consider what may be called the indigenous State irrigation works, the maintenance of which has been undertaken by Government. These works are essentially of the same kind as those which we have just been considering, the difference being that in respect of these no charges have been made to a capital account. It must not be supposed, however, that Government has never undertaken anything more than the bare maintenance. Considerable sums have been spent in improving and developing the works, but it has been found more convenient to charge such expenditure against a revenue account, and to avoid the complications of a capital account.

84. Under this head are included all the inundation canals in the Punjab and Sind which have no separate capital account, and also all the old or native irrigation works in Upper Burma, which resemble those in Southern India, and consist of either tanks or small canals taking off from above temporary or permanent weirs across the beds of minor rivers. But collectively the most important item under this head is the 40,000 tanks, river channels, or other petty irrigation works, which are to be found in the Madras Presidency, and which irrigate between them more than three million acres.

85. *Financial results.*—The following statement shows the areas irrigated by all works of this class, the revenue due to them, and the expenditure incurred on them during the year 1900-01:—

Province.	Area irrigated.	Revenue receipts.	Charges.	Net revenue.
	Acres.	Lakhs of rupees.	Lakhs of rupees.	Lakhs of rupees.
Madras	3,173,250	79·86	22·83	57·03
Punjab	707,525	7·06	4·27	2·79
Bombay, including Sind	1,297,368	32·23	10·16	22·07
Bengal	28,619	0·26	0·41	—0·15
Burma	576,936	19·51	13·38	6·13
Total	5,783,698	138·92	51·05	87·87

Here also the revenue due to two small works in Bengal was insufficient to cover working expenses; but, taking the works in all provinces as a whole, it will be seen that they irrigate nearly six million acres, and that the outlay incurred by the State amounts to about 40 per cent. of the revenue derived from

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them. It must be remembered, however, that part of this expenditure is incurred on improvements which will tend to increase the efficiency of the works and the amount of the revenue derived from them. This is particularly the case on the inundation canals, and on the works in Burma, where heavy expenditure has been incurred since annexation in putting the old works into thorough order, and in rendering them more substantial and permanent.

86. *General financial results for works of all classes.*—The general financial results attained in the year 1900-01, on all the irrigation works then in actual operation, may now be brought together as exhibited in the table below :—

Class of work.	Capital outlay to end of 1900-01.	Interest charges* at 4 per cent. on capital outlay.	Net revenue in 1900-01.	Net revenue less charges for interest.
	Lakhs of rupees.	Lakhs of rupees.	Lakhs of rupees.	Lakhs of rupees.
Major works	36,63·72	1,46·55	2,59·70	1,13·15
Minor works for which capital accounts have been kept	3,20·04	12·80	19·18	6·38
Other minor works	...	...	87·87	87·87
TOTAL .	39,83·76	1,59·35	3,66·75	2,07·40

From this it will be seen that in 1900-01, which may be taken as a normal year, the net revenue derived from all the State irrigation works then in operation exceeded all charges for interest on the capital outlay and for maintenance by over two crores of rupees.†

87. *Abstract of irrigated areas.*—The areas irrigated in 1900-01 by each of these three classes of works in the several provinces may also be brought together as shown below :—

Province.	Major works (productive and protective).	Minor works for which capital accounts are kept.	Other minor works.	Total.
	Acres.	Acres.	Acres.	Acres.
Punjab	4,642,852	602,189	707,525	5,952,566
Sind	961,434	882,956	1,297,368	3,266,152
Bombay	84,472	39,922		
Madras	2,915,271	511,603	3,173,250	6,600,124
Bengal	716,271	...	28,619	744,890
United Provinces	1,888,091	113,793	...	2,001,884
Rajputana	...	34,767	...	34,767
Baluchistan	...	5,232	...	5,232
Burma	...	...	576,936	576,936
GRAND TOTAL .	11,208,391	2,190,462	5,783,698	19,182,551

* The charge for interest has been reduced to 3½ per cent. in respect of all capital outlay incurred since the 31st March 1900, but the difference will be immaterial.

† In a statement prepared by the Accountant-General, Public Works Department, as an accompaniment to his note No. 10-I., dated 5th May 1902, on the Irrigation Accounts for 1901-02, the financial results as affecting the general tax-payer were shown as a net gain or profit amounting to Rs. 1,74,21,485. The difference is due to the fact that for the purposes of that statement it was necessary to include capital outlay on works like the Jhelum and Mandalay Canals which have not been brought into operation, and to exclude the figures for the minor works in Madras for which continuous revenue accounts are not kept, and also all charges for interest on capital expenditure which has been charged against revenue. For the purpose of this chapter the amount now given may be accepted.

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In round numbers it may therefore be said that the State irrigation works yield a net revenue after meeting all charges including interest of about two crores, and irrigate annually over nineteen million acres.

88. *Expansion of the area under irrigation since 1880 and 1898.*—The Famine Commission of 1898 gave a table in paragraph 551 of their report, comparing the areas irrigated under the three classes of irrigation works known as productive, protective, and minor, during the three years ending 1896-97, with the areas during the three years ending 1878-79. We have hitherto considered productive and protective works under the one head of 'major works,' but for purposes of comparing the areas irrigated during the last four years with those given in the report of 1898, it may be convenient to adopt the classification there followed, as in the table below, in which the average areas for three triennial periods are compared with the figures for 1900-01 :—

Class of work.	Average area irrigated annually during the triennium ending with the year			Areas for 1900-01
	1878-79.	1896-97.	1899-1900.	
	Acres.	Acres.	Acres.	Acres.
Productive works . . .	4,645,091	7,774,860	10,465,882	10,868,976
Protective ,, . . .	...	221,030	309,566	339,415
Total major works .	4,645,091	7,995,890	10,775,448	11,208,391
Minor works	5,956,277	7,290,343	6,869,355	7,397,224
GRAND TOTAL .	10,601,368	15,286,233	17,644,803	18,605,615

The areas irrigated in Upper Burma, which had not been annexed in 1878-79, have been excluded from the table. With regard to them it will be sufficient to state that the areas, which are all under minor works for which capital accounts are not kept, have increased gradually from 254,000 acres recorded in 1894-95, to 576,936 acres in 1900-01.

89. *Slow rate of expansion on minor works.*—An inspection of these tables shows that, although there has been a remarkable and continuous expansion since 1880 of the area irrigated by major works, the increase has been mainly under the head productive. The absolute increase of area under protective works during recent years has been small. Few works of this kind have been sanctioned, and those which have been sanctioned are not yet completed or in operation. It is more important, however, to note the very small increase which has occurred in the area under minor works. It seems probable that in the course of a few years the area under major works will be nearly three times as great as the average for the triennium ending 1878-79, but that the minor works will show an increase for the same period of less than 25 per cent. It is not difficult to account for the slow rate of increase under minor works. As long as the expenditure on the construction of new minor works, or the improvement and extension of the older works, is charged against general revenues, progress is sure to be slow and uncertain, and there is a constant tendency to restrict the grants to amounts that are hardly more than sufficient to meet the cost of upkeep of existing works. We have pointed out, in some of our Provincial Chapters, the great field which exists for extensions of the area under minor works, many of which are likely to be directly remunerative; and

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the figures which we are now considering confirm the conclusion that too little has been done in the past for works of this most useful class.

90. *Other State expenditure on minor works.*—We have endeavoured to give in this chapter a general view of the financial, productive, and protective results attained on State irrigation works throughout India, and have referred in greater detail to particular works in the corresponding sections of our Provincial Chapters. We may observe, however, that the figures which we have given relate only to those works, the accounts and returns for which appear in the administration reports of the Irrigation Branch of the Public Works Department, and that the idea which they give of the connection of the State with irrigation works is not quite complete. There are some works, such as the Kabul River Canal, or the Firozpur District Canals in the Punjab, or others undertaken for the improvement of estates belonging to or under the administration of Government which are carried out or managed by Civil officers, with or without occasional technical assistance from the Public Works Department, and are practically State works, but of which no account is taken in this chapter; there are also other important works which have been undertaken and carried out in Native States under the advice or supervision of Government officers. Lastly, we have excluded from these statements a considerable expenditure which is met from the minor works grant and incurred by the Public Works Department on irrigation and agricultural works, such as the flood embankments in Bengal, Burma, and Madras. Works of the latter kind may have a great protective value in tracts which are liable to heavy floods, but we have thought it more convenient to confine our attention in this chapter to works which give protection against drought. It is difficult to obtain reliable information as to the protective value of flood embankments, but in Burma alone between 400,000 and 500,000 acres are annually assessed at rates averaging more than Rs. 2 per acre on account of the protection afforded by such works, on which a capital outlay of nearly forty lakhs has been incurred.

91. *Comparison of areas irrigated by State and private irrigation works.*—Before concluding this chapter we would invite attention to the statement given in paragraph 46, from which it appears that great as is the area which is now irrigated from State irrigation works, the area dependent on private irrigation works is even greater, although it is not always so fully and reliably protected. Out of a cultivated area of 226 millions of acres in British India over $18\frac{1}{2}$ millions receive irrigation from State works; whereas the area reported as irrigated from wells, private canals, tanks, and other sources, amounts to over $25\frac{1}{2}$ millions of acres, of which more than half is under wells. Considering both the extent and the efficiency of the protection afforded, it may be said that State and private irrigation works play an almost equal part in the protection of the country from drought. We shall consider in the two following chapters the scope which exists for the extension and development of both these means of irrigation.

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Chapter IV.—SCOPE FOR FURTHER EXTENSIONS OF STATE IRRIGATION WORKS.

Section I.—PROTECTIVE VALUE OF IRRIGATION.

92. *Introductory.*—It has been laid down in our instructions that the main question as regards new works is not whether they will be likely to prove directly remunerative, but whether the net financial burden which they may impose on the State, in the form of charges for interest and maintenance, will be too high a price for the protection against famine which they may be relied on to afford; and that it is from this point of view that we should consider proposals for the extension of irrigation in districts in which cultivation is very insecure and precarious. This instruction renders it necessary that we should consider very carefully the financial prospects of all proposals, with a view to determining the actual price which the State will have to pay for the protection which they will afford, and the real value of that protection.

93. *Indirect advantages of irrigation.*—It has often been urged that the indirect advantages of irrigation in India are so great and incontestable that the question of the direct financial return which may be anticipated on the capital outlay is one of minor importance to which very little regard should be paid. This proposition is not likely to commend itself to those who are responsible for finding the large sums of money required for the construction and maintenance of irrigation works; and it seems desirable to form a clear idea of the nature of the indirect advantages which are claimed for irrigation works, and of their comparative, if not absolute, value to the State in different circumstances. These advantages are of three kinds, each of which must be considered separately:—

(*a*) The increase in the general wealth and prosperity of the community resulting from the increase in the produce of cultivation due to irrigation even in years of normal or more than normal rainfall.

(*b*) The effect of irrigation and of large water storage works in increasing the humidity of the air, and in raising the level of the underground water-supply.

(*c*) The prevention or mitigation of the horrors and the cost of famine.

94. The value of irrigation in increasing the wealth and food supply of the country cannot be doubted; and although the amount or percentage of this increase varies greatly for different tracts, it can generally be estimated approximately for particular tracts in which irrigation works have been for some time in operation. There are, however, obvious limits to the permanent charges which the State may reasonably be expected to meet for the purpose of increasing the produce or the profits of cultivation in particular tracts. The value of the crops which have been irrigated in a single year is often compared with the capital cost of the works. The comparison may be interesting, but it is very misleading as an indication of the value of the work. In the first place, the value of the crops which receive irrigation from a canal does not always represent the value of the increase of produce due to irrigation. It may do so in parts of Sind and the Punjab where cultivation without irrigation is impossible, but not on the Orissa or Kurnool-Cuddapah Canals: on the former canal, owing to the generally copious rainfall, the difference in the value of irrigated and unirrigated crops is small in ordinary years; and on the latter the people find it more profitable to cultivate large areas of dry crops, for which the rainfall is ordinarily sufficient, than to put a smaller area under wet (rice) cultivation. But when the increase in the value of produce due to irrigation has been determined, it must be compared not with the capital cost of the works, but with the annual net charge for interest and maintenance which they impose on the State. We have found that there are many works on which this charge varies from Rs. 5 to Rs. 8 per acre irrigated. *Primâ facie*, there is no more reason for calling on the State, or, in other

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words, on the general tax-payer, to bear a permanent charge of, say, Rs. 6 per annum, for the sake of increasing by irrigation the produce of an acre of land belonging to a private owner, than there would be for calling on it to pay a similar amount for the purpose of supplying another man's acre with manure. Apart from the question of famine protection, which will be considered separately, the maximum permanent charge which the State may reasonably undertake in providing irrigation, should theoretically be limited by the share of the increase in the value of produce due to irrigation which it will be able to recover indirectly. It is hardly necessary to say much here as to the manner in which a share in the increase of the wealth of the community comes back, in some indirect form or other, to the State, as by the increase in railway earnings or in the revenue derived from excise, stamps, income-tax, etc., or by other ways in which the State shares in the prosperity of the country; but a measure of this share may be proposed which will be sufficient for our present argument.

95. The best measure of the increase in the profits of cultivation due to irrigation appears to us to be the amount which the people are willing to pay for it, that is, the gross revenue of the works. The two main factors in this item are the area under irrigation and the pitch of the water rates, with each of which the increase in the value of produce is likely to vary more or less directly. We have found that water rates vary from one-twelfth to one-fifth of the value of the crops irrigated, the proportion depending to a great extent on the value of irrigation in increasing the produce. If, then, the gross revenue may be taken as a measure of the profits accruing to the cultivator from irrigation, a certain percentage of this revenue may again be taken as a measure of the indirect return to the State which results from these profits. We cannot say what this percentage should be, but for comparative purposes the exact rate is not a matter of great importance, and we will assume it at 25 per cent. That is to say, that if the State receives Rs. 4 per acre from the cultivator as water rate, in consideration of the increase in the profits of cultivation which he will derive from irrigation, it may be assumed that it will receive 25 per cent. of this amount, or Re. 1 per acre, in some indirect way, either from the cultivator himself or from those who share in his prosperity. This will probably be thought an outside estimate of the share of the increase in the wealth of the country which comes back indirectly to Government; but it enables us to form a definite idea of the comparative effect of the indirect advantages on the financial position of an irrigation work, as shown in the following table, which has been prepared for a number of typical canals or systems of canals. The term 'indirect return' is used in it, and in this chapter, in a special sense to represent the intangible return which is assumed to accrue to Government, and not in the technical sense referred to in paragraph 229 (Chapter VIII). This indirect return is assumed to be in each case one-fourth of the gross revenue shown in column 4. It is added to the net revenue in column 5, and the return on the capital cost shown in the last column is then struck.

Names of works.	Area irrigated annually in thousands of acres.	Capital cost in lakhs of rupees.	Gross Revenue in lakhs of rupees.	Net Revenue in lakhs of rupees.	Return on Capital.		
					Direct.	Indirect.	Total
1	2	3	4	5	6	7	8
Punjab Major Works (*a*) .	4,357 (*c*)	920·76	146·16	103·14	11·2	4·0	15·2
Godavari and Kistna Canals (*a*)	1,375 (*d*)	269·69	60·54	45·16	16·8	5·6	22·4
Kurnool-Cuddapah Canal (*a*) .	61	217·33	1·77	·68	0·3	0·2	0·5
Sone Canals (*b*) . . .	481	267·52	11·12	5·07	1·9	1·0	2·9
Orissa Canals (*b*) . . .	202	264·48	3·99	—·52	—0·2	0·4	0·2
Betwa Canal (*a*) . . .	33	45·07	·57	—·36	—0·8	0·3	—0·5
Bombay Canals, Class B (*e*) .	46	86·71	1·58	·68	0·8	0·5	1·3

(*a*) For the year 1900-01.
(*b*) Averages for 3 years ending 1901-02.
(*c*) Exclusive of 286,000 acres irrigated on Native States branches of Sirhind Canal and Patiala Section of Sirsa Branch, Western Jumna Canal.
(*d*) Exclusive of 50,000 acres assumed as old irrigation.
(*e*) Averages for 10 years ending 1900-01.

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96. We have no hesitation in admitting that there is a real, although intangible, indirect return on successful irrigation works, which may properly be taken into account when new works are proposed; but the foregoing table indicates how easily these indirect returns may be exaggerated. As might be expected, they are considerable when the direct returns are high, but of little absolute value when these are low. On the provisional assumption that they amount to 25 per cent. of the gross revenue, the indirect return for the great productive works in the Madras deltas and in the Punjab will vary from 4 to 6 per cent. on the capital cost; but for unremunerative works the percentage is fractional and the amount of the indirect receipts very small. If we assume a lower percentage on the gross revenue, they will become quite inconsiderable. The rate of interest to be charged on future capital expended on irrigation works is $3\frac{3}{4}$ per cent.; but, if allowance be made for interest charges during construction and until irrigation is fully developed, it may be assumed that no work will fulfil the conditions of a productive work unless it will yield a return of 5 per cent. on the actual capital cost, excluding charges for interest during construction. If a work is likely to yield this return, it is unnecessary to consider the question of indirect returns; and if it will not yield a return of 3 per cent., the indirect returns in themselves are not likely to be considerable enough to justify its construction. Where the direct return is likely to vary between 3 and 5 per cent., more weight may be given to the claim of indirect returns, and the work may probably be constructed without involving much risk of any real loss to the State. Speaking generally, we may say that, although the indirect returns on a highly productive work, and the increase in the wealth of the country, of which they are a measure, are great and undeniable, they are small and inconsiderable on works which are unremunerative, and that it is only in a few cases that it will be necessary to take them into account. When the advantages offered by irrigation works are so small or restricted that the people who enjoy them are not able to pay the cost of providing them, it may be inferred that, whatever value they may have in years of famine, their effect in increasing the wealth of the country is also small. This may seem almost a truism; but so much is often said about the great indirect value of irrigation works which will not pay their way, that we have thought it necessary to discuss the subject at some length.

97. When the charge for irrigation takes the form of an enhancement of land revenue, there is a consequent increase in the proceeds of local cesses which deserves notice. This increase is not credited to the works because the money is spent locally in providing improved roads, schools, dispensaries, etc., for the benefit of those who contribute it. It is not therefore a State asset; but one of the indirect advantages of new irrigation works lies in the fact that they lead to an increase in the cesses, or local funds, available for the betterment of the agricultural community.

98. The effect of irrigation and of large storage works in increasing the humidity of the air, or in raising the spring level in wells, can hardly be disputed; but its value necessarily varies very much in different localities. It can be of little benefit in the deserts of the Punjab and Sind, where the spring levels in wells are at unworkable depths, and dry hot winds are continually blowing; or in the Orissa delta, where there is a normal rainfall of 60 inches and well irrigation is hardly practised; or in tracts which now suffer from water-logging and very high spring levels. But tanks and irrigation may have a great indirect value in such tracts as Bundelkhand, Central India, the Rajputana States, and the Bombay or Madras Deccan. The exposure of large surfaces of water to evaporation must tend to increase the humidity of the air, and water evaporated in one place will be precipitated in another. Still more important, or at any rate more palpable, is the effect on the spring level, and on the percolation flow which can be picked up from the beds of streams by spring channels or from above small weirs. But it is impossible to assign any quantitative, and still less any money value to these effects. It is sufficient to recognize them as operative in various degrees in the tracts in which protective irrigation works are most required, and as constituting an additional argument for their construction, although it is one upon which, by itself, much stress cannot be laid.

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99. The important question of the value of protective irrigation works in preventing or mitigating the cost and horrors of famine, has next to be considered. We have already observed that, *apart from the question of famine protection*, there is no reason why the State should accept a permanent charge on the revenue for the sake of increasing the productiveness of land belonging to private owners; and that at any rate such charge should be limited to the amount which may be recouped by the share of the increased produce which will come back to it in an indirect form. The reservation in respect of famine protection is, however, all-important. The obligation on the State to incur whatever expenditure may be necessary to save life during famine, involves future liabilities which cannot be evaded, and of which full account must be taken. We have therefore to consider what immediate expenditure on unremunerative protective works may be justified by the reduction that it will effect in the amount of these future liabilities; or, in other words, what reduction in the future direct cost of famine to the State may result from a given expenditure on such works. For the present we may disregard the indirect cost of famine to the State, and the loss and misery which famine imposes on the people; and confine ourselves to the purely economical question of the comparative demands on the tax-payer, involved in an immediate expenditure on protective irrigation works, and in the future relief of the distress which may be anticipated if these works are not constructed.

100. This is a question to which we have devoted a great deal of attention, but of which a direct and satisfactory solution appears to be hardly possible. If we could obtain reliable particulars of the expenditure on different groups of villages, enjoying different measures of protection by means of irrigation, but all situated within an area in which all other conditions affecting the cost of relief were approximately identical, it might be possible to estimate the saving in the cost of relief which could be attributed to every irrigated acre; and to equate the estimated annual cost to the State of extending the irrigated area with the saving which would result in the cost of famine relief, on the recurrence of famines of similar intensity after assumed intervals of time. The available statistics do not, however, show the expenditure on relief works by villages, but by works, and it is not possible to ascertain the number of units from particular villages who were relieved on the works. The conditions which induced the people to resort to relief works varied so much in adjacent areas, and even at different times within the same areas, that no reliable conclusions could be derived from details of the attendance, even if they were available. It is unnecessary, however, to explain at length all the difficulties which prevent a satisfactory solution of the problem which we are considering; but a few figures may be given which will indicate a maximum limit to the expenditure which may be justified as a preventive of the direct cost of famine.

101. There are few districts in which the cost of famine relief has been greater than that of Sholapur in the Deccan. During the last 33 years, or third of a century, this district has suffered from famines, as noted below—

1876-77 . .	Severe famine, expenditure not known.
1891-92 . .	Scarcity—no relief given, but it would probably be given now under similar conditions.
1896-98 . .	Acute famine—cost 45 lakhs.
1899-1902 . .	Intense and prolonged famine—cost 70 lakhs.

The amounts shown as the cost of the last two famines have been based on figures supplied by the Collector of Sholapur, which give all expenditure to the end of November 1901, including the losses due to irrecoverable advances and to remissions of land revenue. Five lakhs have been added to the cost of the last famine as shown by the Collector, to cover expenditure incurred subsequently to November 1901. If we assume that one famine such as that of 1899-1902, and two famines such as that of 1896-98, are likely to occur in every third of a century, we may estimate the cost at 160 lakhs, or say 5 lakhs a year. Capitalized at 4 per cent. this amounts to 125 lakhs, which is the arithmetical limit to the unproductive expenditure which may be incurred for

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the sake of avoiding the future cost of famine relief. If more than this is spent, the payment of the annual charges for interest is likely to impose a heavier burden on the tax-payer than the cost of famine relief.

102. *Protective value of an irrigated acre.*—The next question to be considered is the additional area to be brought under irrigation in order to protect the district to the extent necessary to prevent any charges for famine relief in future. The Sholapur district has a population of 721,000, and the area normally sown and cultivated may be taken at 2,000,000 acres, or about $2\frac{3}{4}$ acres for each head of population. After considering the relation of the protected area elsewhere to the normally cultivated area and to the population, and to the demands for famine relief, we think that the minimum area that should be protected by irrigation in order to prevent charges for famine relief in future, cannot be estimated at less than 0·4 acres per head of population, which should, however, be assumed at 800,000, to allow for future increase. The population in this district decreased by 30,000 during the decade ending 1900-01, and this decrease will no doubt be more than made good with the return of more favourable seasons and the extension of irrigation. For such a population there should be a protected area of not less than 320,000 acres, of which it may be said that 100,000 are now protected by wells and existing irrigation works, leaving 220,000 acres for which irrigation should, if possible, be provided. Assuming that Rs. 1,25,00,000 is the maximum unproductive expenditure which may be incurred on the strength of the saving anticipated in the future cost of famine relief, the amount which may be thus spent for every acre brought under irrigation will be Rs. 57. This may be called the "*direct protective value of an irrigated acre*" in the district of Sholapur. If it be thought that a larger area than this must be brought under irrigation in order to prevent all liability for the cost of famine relief, the direct protective value of an acre will be so much the less.

103. It has already been observed that, when allowance is made for interest charges during construction and up to the time that an irrigation work is fully developed, a work cannot be considered as likely to prove directly remunerative if the ultimate net revenue will yield a return of less than 5 per cent. on the capital cost, excluding charges for interest. The limit to the capital cost per acre for a remunerative work will thus be the capitalized value at 5 per cent. of the net revenue which may be expected per acre of average annual irrigation. Thus, if the net revenue from a work in the Sholapur district were estimated at Rs. 2-8 per acre, the work would be remunerative if the capital cost did not exceed Rs. 50 per acre. But if allowance also be made for the direct protective value of an irrigated acre, a capital expenditure of 50 + 57 = Rs. 107 per acre might be contemplated. There is, however, very little prospect of any irrigation work being constructed in Sholapur at so low a rate as this.

104. It will, however, be said, and truly said, that the protective value of an irrigated acre cannot be limited to the saving that it may effect in the future cost of famine relief. There is an indirect loss of revenue due to famine, of which account must be taken, in the loss of land revenue due to land going out of cultivation or to the great impoverishment of the cultivators; and there are corresponding losses in the revenue from excise, customs, salt, stamps, etc., all of which are likely to continue for some time after famine has passed away. The total of these losses, if it could be fairly estimated, would possibly not fall short of the recorded actual cost of famine relief, including remissions of land revenue, etc., which is all that we have hitherto considered. But, over and above all this, it may be contended that the expenditure which Government may legitimately incur on famine prevention cannot be limited by a consideration of the reduction in the future cost of famine to the State which will result from such expenditure; and that a much higher scale of expenditure may be justified, for the sake of saving the inhabitants of insecure tracts from all the losses and demoralization and miseries of famine.

105. It is unnecessary to expatiate on this argument which we should be the last to contest. It is difficult to propose any limit to the expenditure which

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the State may incur in order to prevent what has been called the scandal of famine. But vague generalities on the indirect profits of irrigation and losses of famine are of little use in considering the question whether the net financial burdens which particular works may impose on the State, are too high a price to pay for the protection which they will afford. A scale of some kind is necessary by which we can measure the comparative weights of these burdens, and the corresponding protective advantages; some definite idea is wanted as to the share of unproductive expenditure on a work which may be justified on the ground of the saving that will be effected in the future direct cost of famine to the State; and it may be left to Government to decide how much more than this may be contemplated for the sake of protecting the community from all the evils of famine.

106. The best scale which we can suggest is that afforded by the direct protective value of the irrigated acre. It may be estimated, as we have shown, for any particular tract, by considering, in the light of past experience, the probable cost of famine relief in the future, the population, the area usually cropped, the area which may be regarded as protected, and the minimum area that should be protected in order to tide over a period of severe drought. The calculation which appears to us most suitable may be expressed symbolically by the formula—

$$x = \frac{F}{Pn-a}$$

Where x=The direct protective value of an irrigated acre, or the capitalized value, at 25 years' purchase, of the saving in average annual cost of famine which will be effected by every acre brought under irrigation.

F=Estimated total cost of famine in the given tract for a period of 25 years, or quarter of a century.

P=Population of the tract, with necessary addition for prospective increase.

n=Area in acres which should be protected by irrigation for each head of the population.

a=Area in acres already protected.

The co-efficient n will vary in each tract, but for insecure tracts it will probably never be less than 0·3 or more than 0·5. Other things being equal, the value of n should diminish as the area normally cropped per head of population increases; but the character of the cultivation, nature of staple crops, and other points affecting the question, require consideration; and when possible the conditions in villages which are adequately protected within the same tract should be considered. The value of x (Rs. 57) which we have proposed for Sholapur may probably be regarded as nearly a maximum for a whole district, as there are few districts which have suffered so much from famine. If therefore the value could be worked out for all districts (although a smaller unit, such as the *taluka*, would be preferable), we should expect to find it varying from a maximum of Rs. 60 in the Deccan, to *nil* in those districts which may now be regarded as secure.

107. *Permissible capital outlay per acre.*—As we have before stated, we do not desire to propose that the unproductive share of the capital cost of bringing an acre under irrigation should be limited to the value of x; although it should probably be limited with reference to this value, for the direct protective value of an irrigated acre will be a very fair measure of its total, or direct and indirect, protective value; or, in other words, the recorded famine expenditure is a fair measure of the intensity and severity of the famine. Let it be assumed, for the sake of example, that this total protective value may be taken at three times the direct protective value, or x; that is to say, that we may contemplate an unproductive capital expenditure of $3x$ rupees per acre, in consideration, not only of the reduction which will be effected in the future direct cost of famine, but also of the indirect profits which will

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accrue to the State under the heads (*a*) and (*b*) referred to in paragraph 93, of a reduction in the unreported, or indirect, cost of famine, and, above all, of the protection to be afforded to the community from all the evils of famine. Then, if it be assumed as before, that every acre of average annual irrigation will yield a net revenue of Rs. 2-8, a capital expenditure of Rs. 221 per acre might be contemplated on new irrigation works for the Sholapur district; or generally, if

$(20 \times 2{\cdot}5)+(3 \times 57)=221.$

C = Permissible capital cost per acre.
x = Direct protective value of an irrigated acre.
r = Anticipated net revenue per acre of average annual irrigation.
m = A multiplier, representing the ratio of the total protective value of an irrigated acre to its direct protective value.

Then $C = 20\,r + mx$.

108. Our inquiries indicate that the cost of irrigating an acre in many parts of the Deccan, by canals with a plentiful or reliable supply, is likely to exceed Rs. 200 per acre, while the net revenue per acre may vary from Rs. 2 to Rs. 3. If canals are to be constructed in this tract at all, it would seem that a value for m, not differing very widely from our proposed value of 3, must be accepted; or, in other words, that Government must be prepared to face an expenditure equal or nearly equivalent to three times the estimated future cost of famine relief and remissions of revenue, for the sake of preventing famine altogether. Then, if the average direct cost of famine in Sholapur be estimated at 5 lakhs per annum, the annual cost of preventing this expenditure may be estimated at 15 lakhs. The net direct cost to the State would therefore be 10 lakhs. Some of this would be recovered by the avoidance of all the losses of revenue indirectly due to famine, but the balance will represent the cost of substituting a policy of famine prevention for one of famine relief.

109. We do not mean to say that this value of the ratio m is too high, or that it will involve, in the particular cases to which it may be applied, an expenditure out of all proportion to the advantages to be gained by preventing famine in place of relieving it. The protection which it would furnish would not be more costly, when considered with reference to the liabilities for famine expenditure which it would prevent, than that which has been afforded by such works as the Orissa, the Kurnool-Cuddapah, and the Betwa Canals, and many of the existing irrigation works in Bombay. It is true that the construction of these works was not deliberately sanctioned, with a full foreknowledge of the unsatisfactory financial results which would be attained; but we believe that the protective value of all has been great enough to prevent any one from regretting that they were constructed. We are inclined to think that the value of this ratio m which we have assumed, is not too high; provided always that it is applied only to cases in which the water-supply is so secure that the contemplated protection may be regarded as assured even in the worst years of drought, when the protection will be most urgently needed. When there is doubt on this point, a much lower value should be taken. We think, too, that the value proposed should be regarded, at any rate for some time to come, as a maximum. But the final determination of the limits to the expenditure which may be legitimately incurred for the sake of preventing, so far as irrigation works can prevent, all the great evils of famine, does not rest with us. All that we can do is to direct attention to some of the elements of the problem; and to point out, in reply to those who contend that the whole of India can be securely protected against famine by the construction of irrigation works, that even when this is physically possible, there is a limit to the expenditure which may be incurred, and a risk of imposing a burden on the country which may be even greater than that of famine itself.

110. We have considered here what we have called the protective value of an irrigated acre, as the only possible method of approaching the problem to be dealt with. If we could have obtained for every famine district reliable estimates of the cost of all the protective irrigation works which could be proposed,

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of the net revenue which would be derived from them, and of the areas which they could efficiently protect, we might probably have hazarded a conjecture as to the probable net cost to the State of carrying out such works. But such estimates were not and could not have been available. The cost and the net returns of a protective irrigation work cannot, like those of a protective railway, be approximately estimated at so much a mile. Nor can we say, as has actually been said, that inasmuch as the capital cost of the Godavari works has not exceeded Rs. 18 per acre, it is sufficient to allow something more than double this rate, or Rs. 40 per acre, as the probable cost per acre of the great Tungabhadra project. The mere cost of the works in any particular case, and especially when storage is involved, can only be approximately estimated after long investigation and careful inquiry. But this is nothing to the difficulty in determining the areas which will be irrigated in wet, in normal, or in dry years, or the revenue which can be derived from irrigation—factors which profoundly affect all estimates based, as all estimates must be, on acreage rates. Reliable estimates on all these points, without which it would be very imprudent to sanction any expensive work, can only be submitted separately for consideration on their merits. It will not be possible to protect every tract which is in need of protection, and individual estimates will relate only to small portions of these tracts. It thus becomes necessary to form some idea of the permissible capital cost per acre to be irrigated in any particular tract, as the only possible guide to the probable net cost to the State of carrying out such projects as may be proposed.

111. It must not, however, be supposed that we estimate the probable net cost of protecting any tract which is now liable to famine, at a sum which is equivalent to three times the probable expenditure on famine relief. There are no doubt many tracts in which protection cannot be provided at a less cost than this, and they are generally the tracts in which protection is most urgently required. But there are others in which it may be hoped that the unproductive outlay will be much less. Works which will be productive, or in which the capital cost is not likely to exceed 20 times the net revenue, will not involve any unproductive outlay, and it will be unnecessary to consider the question of their protective value at all. And we think that, in all tracts in which the cultivation is at all insecure, protective works may be sanctioned without hesitation whenever the capital cost is not likely to exceed thirty times the net revenue, or whenever a net return of more than 3 per cent. on the capital outlay may be anticipated. The indirect returns which will accrue on the expenditure, and the protective value of the work, will certainly suffice to justify the sanction. When a lower return than this is anticipated, it will be necessary to pay closer attention to all the circumstances of the case; and especially to the urgency and the certainty of the protection which the work is designed to afford. In such cases the work will either be abnormally costly to construct or maintain, or the value of irrigation, except in years of extreme drought, will be so small or doubtful as to justify caution in according sanction. This examination of the subject leads to the conclusion that, however great may be the indirect value of irrigation works which may be classed as productive, it will diminish rapidly for works on which the direct returns are likely to fall below the productive standard, and may become so inappreciable, even in districts which are liable to frequent famine, as to render the construction of the works inexpedient.

Section II.—PROBABLE COST OF NEW WORKS.

112. *Productive works.*—It has been shown that the major irrigation works hitherto constructed by the State have, on the whole, proved so remunerative that they yield a surplus revenue, after all charges for interest have been met, of over 113 lakhs, the net revenue being equivalent to a return of 7·1 per cent. on the capital cost. The first point that strikes us, in approaching the question of the scope for further extensions of State irrigation works, is the limited field for the construction of new works which are likely to be equally remunerative, or even to be at all directly remunerative,

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There is not a prospect of new irrigation works, on any considerable scale, proving directly remunerative in any of the provinces in which protective irrigation is most urgently required, namely, the Deccan districts in Bombay and Madras, the Central Provinces, and Bundelkhand. The only provinces in which there is a considerable field for new irrigation works which are almost certain to be remunerative are the Punjab, Sind, and possibly Madras. In the Punjab, there is first the great project for the irrigation of the Lower Bari Doab, which will probably prove highly remunerative, whatever may be the form which it will ultimately take, or whatever may be the magnitude of the scheme. The prosecution of this work is likely to extend over several years, and if the next great Punjab project, the Sind-Sagar Canal, is then undertaken, it will probably be in the expectation that it will fulfil the conditions of a productive irrigation work, although it is not likely to prove highly remunerative. Any other new works that may be proposed in this province are likely to be remunerative; and the same may be said of Sind, where all capital expenditure on the inundation canals has hitherto proved exceedingly profitable. Almost all proposed new works in Madras involve the construction of storage works, and although many of the existing storage works in the Presidency are remunerative, there are some which are not; and it is at least doubtful whether many of the new works will be so, and almost certain that the greatest of them all, the Tungabhadra project, will not. If a sufficiently large area of rice-growing land can be commanded, it is possible that the proposed Tapti Canal may fulfil or nearly fulfil the conditions of a productive irrigation work; but this is at present doubtful, and it is almost certain that no other large work can be proposed in Gujerat which will be directly remunerative. All existing works in the United Provinces, north of the Jumna, are highly remunerative; but there is not much scope for new works outside the Sardah project, and it may be doubted whether that would fulfil the conditions of a productive work if carried out as originally proposed, but this we have not recommended. The new works proposed south of the Jumna, or in Bundelkhand, are certain to be unremunerative. In Bengal no irrigation work hitherto constructed has proved remunerative; although it appears not improbable that the Tribeni Canal, now under construction, may nearly fulfil the prescribed condition, as it has the great advantage of an assured and ample supply, and it commands a rice-growing country in a very insecure tract. We have, however, been unable to propose any new works in Bengal which are likely to be remunerative.

113. Although the field for new productive works is limited, there is scope in almost every province for considerable expenditure in extending or developing existing works. Expenditure of this kind, which is chargeable to the open capital accounts of the works, is almost certain to be remunerative, even when the works themselves taken as a whole are not.

114. Many of the new productive works that may be proposed in future, including almost all extensions of existing works, will be situated in provinces or districts which are already adequately protected, and they will not be urgently required for protective purposes. Nevertheless all productive works must be regarded as essentially protective. The direct revenue which they earn is a valuable asset, more especially as it is usually at a maximum in years of drought when so many other sources of revenue are liable to contract. As already shown, it is a measure of the increase in the wealth of the country due to the works, a large share of which comes back to the State indirectly. Population is attracted from the more congested districts, and in times of famine many emigrants from distressed tracts find agricultural employment on the new areas brought under cultivation. Every extension of irrigation increases the security of the food supply of the country in years of drought, and, in these days of cheap railway freights, the produce of irrigation can be carried to those parts in which it is most required. For these reasons we think that the programmes of future expenditure on irrigation works should provide for the construction of as many productive works as can be proposed, in whatever parts of the country they are situated, and without reference to the urgency of protection for the

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locality. Promising projects should be held in abeyance only when funds cannot be allotted for them without interrupting progress on irrigation works of any kind which have been actually commenced, or withholding money from works more urgently required for protective reasons; or when adequate establishment is not available for carrying out the works; or when the success of the works depends upon colonization operations which it may be more convenient on general grounds to postpone.

115. *Protective works.*—We have next to consider the class of works which are called protective, not necessarily because they have a greater protective value than the productive works, but because they have been sanctioned in consideration of their protective value although they were not expected to fulfil the condition of a productive work. The majority of new works are likely to be of this kind, or only partially productive.

116. It is not difficult to understand why the works to be constructed in future should be much less promising, as financial investments, than those which have been constructed in the past. Before those works were constructed, the districts in which they were situated all needed protection, and it was but natural that attention should first be directed to schemes which promised not only the best financial results, but also a much larger measure of protection to the country at large, than could be attained by works of a less remunerative character. The result of this policy has been an increase to the revenue of the country which now exceeds three-quarters of the amount of the Famine Grant, and will before long fully equal that amount—an increase which may now be fairly utilized, as recommended by the Famine Commission of 1878-80, in extending the blessings of irrigation to tracts which are less able to pay for them. But, although this sufficiently accounts for the fact that possible new works are much less promising as financial investments than the works which have been constructed, the fact itself may be expressed in another way. The works of the past have, with few exceptions, been canals fed from large rivers, on which storage works were unnecessary. Even the exceptions are significant. For the excepted works have all proved unremunerative, owing either to the great cost of the storage or to the inefficiency of the work for want of storage. For the works of the future, storage will be essential. Except in the provinces of the Punjab, Sind, and Oudh, not a single work of any importance can be proposed which does not involve the construction of expensive storage works, or for the full development of which storage works will not eventually be required. We have already given reasons for anticipating that, in many tracts, the net cost to the State of protective irrigation works may be equivalent to not less than three times the cost of relieving famine within the area to be protected. This is mainly due to the great cost and uncertain operations of storage works, which are so seldom adequately realized that it may be convenient to consider the subject in greater detail.

117. The Provincial Chapters of this report show how much has been done for the protection of the country by existing storage works; and we have just pointed out that all future extensions of irrigation, in the provinces of India which are most subject to famine, depend on the construction of storage works. But to us the word "storage" is as suggestive of the limitations as of the possibilities of irrigation as a means of protection. We have pointed out the difficulties connected with the construction of storage works, and the physical considerations by which the possibility of impounding any large proportion of the waters which now flow uselessly to the sea is limited. We shall here consider, therefore, only the limitations which are imposed by the question of cost.

118. We have obtained particulars of the cost of twenty storage works in the Bombay Presidency, with an aggregate capacity above outlet level of 20,792 million cubic feet, the capacity of individual works varying from 15 to 5,500 million cubic feet. We find that the actual cost of the reservoirs, including dam, escape, outlet, and compensation for land, but excluding establishment charges, has averaged Rs. 465 per million cubic feet. This is the actual cost of impounding water, to which has to be added the cost of the canals,

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distributaries, and other works for conveying the supply to the area to be protected, and all charges for establishment, tools and plant, etc. With these additions, the total cost of the works averages Rs. 1,275 per million cubic feet. With these figures may be compared those for the Periyar project in the Madras Presidency, in which there is a storage of 6,480 million cubic feet. The cost of the reservoir, including the outlet, has been at the rate of Rs. 653, and that of the whole project at the rate of Rs. 1,364 per million cubic feet.

119. The area that can be irrigated, per million cubic feet impounded, varies very much according to the circumstances of supply and demand, the range being from 2 to 12 acres. In some works, like the Periyar or Lake Whiting (Nira Canal), the reservoir impounds only a portion of the annual yield of the catchment, and for several months in the year there may be an abundant surplus which greatly brings up the duty. Other tanks seldom or never fill, they have no surplus, and rarely store up to their full capacity. The area will also depend upon the kind of crop sown—an acre of sugarcane taking as much water as, perhaps, eight acres of wheat—and also on the character of the season. The average area irrigated from the Bombay works during 10 years has not exceeded 3·6 acres per million cubic feet; but the maximum rate, which is attained in dry years in which the tank supply has not failed, may be taken at 6 acres. If this rate could be worked up to in all years—a consummation which may perhaps be hoped for as the advantages of irrigation become more appreciated—the capital cost per acre would not be less than Rs. 212. If a net revenue of Rs. 2-8 be assumed and capitalized at 5 per cent., the share of the capital cost which would be productive may be taken at Rs. 50, leaving Rs. 162 upon which no direct return would be received. This is a much better result than has yet been attained, and there are reasons for anticipating that the net cost of new works in the Deccan may be even greater than that of those already constructed, and that, after deducting the share which may be regarded as productive, it may not fall far short of Rs. 200 per acre. The irrigation of 500,000 acres at a rate of Rs. 180 per acre would involve a permanent charge on the revenues of the country of Rs. 45,00,000 per annum, and would not entirely prevent famine even if very evenly distributed. We do not say that the advantages of such exemption from famine as the works would afford, would not be worth the cost. But it is obvious that we are approaching a limiting rate beyond which protective irrigation will become financially impossible for any Government; and that, even at the rate assumed, there are limits to the area which Government can prudently undertake to protect.

120. The net cost of storage works per acre irrigated will probably be less in other provinces, even if the cost of impounding and distributing a million cubic feet of water be the same; although this also should be much less in tracts well suited for tank irrigation, as for instance the Bhandara district in the Central Provinces. In Madras a higher rate of net revenue per acre will probably be obtained, and in the Central Provinces a higher duty may be expected. But these more favourable tracts are, as a rule, in less urgent need of protection; and, although the cost of protection may be less, its ratio to the probable future cost of famine in the tract concerned may not be less than it is likely to be in the Deccan. From this point of view there is a limit to the expenditure which may be legitimately incurred on famine protection, even when the actual cost of the works is not very high. It may, for instance, be better to spend Rs. 180 per acre in Bombay than Rs. 90 per acre in Chhattisgarh.

121. It must also be pointed out that, on most of the works which we have been considering, the areas irrigated in a year of keen demand have been limited only by the capacity of the storage reservoirs, which have not been designed to hold more than a year's demand. It is unnecessary to discuss here the question of the ratio which the capacity of a storage work should bear to the minimum or average yield of the catchment area, or to the average demand for irrigation. Each particular case must be considered on its merits. There is an undoubted risk that storage works which are not situated in the regions of unfailing rainfall may fail seriously in a year of drought, although experience shows that failure occurs less often than might be supposed. If, in order to meet this risk, storage

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works are designed, as has sometimes been suggested, to hold a supply equal to twice the requirements of the area which they are intended to protect, the cost per acre irrigated will be very much higher than in the examples which we have considered; and the double capacity, although it will reduce the risk, will not be a complete insurance against failure, especially if a succession of dry follows a series of wet years. It may often be very desirable to provide excess storage; but in many storage works complete insurance against failure can only be obtained by a prohibitive increase in cost.

122. Irrigation by means of storage works is, in fact, subject to the same practical limitations as the storage of electrical energy. Secondary batteries or accumulators are of the greatest value for the purpose of equalizing the supply, and for continuing it when the machinery has broken down or stopped; but unless they can be recharged at frequent intervals, their size and cost are so great as to render their use impossible. So it is with irrigation. Storage will be indispensable in almost all works of the future, and, in spite of their cost, they will be of the greatest value in maintaining a supply for irrigation through all the vicissitudes of a single season. They can do more than this only if they are constructed in a region of unfailing rainfall, or with a capacity greatly in excess of the average annual demand; but compliance with either of these conditions must often result in an increase of cost which will be regarded as prohibitive. Storage is so costly, even in the most favourable circumstances, that very few irrigation works which depend on it are remunerative; and under adverse conditions it becomes financially impossible.

Section III.—CONSTRUCTION PROGRAMME AND FORECAST.

123. *Introductory.*—We have shown that very few of the new State irrigation works which can be proposed are likely to be remunerative, as the most promising projects have already been carried out, and almost all those which remain will depend on such uncertain sources of supply as to necessitate the construction of expensive storage works. We have also discussed the relation which the net cost to the State of these works is likely to bear to their value as a protection against famine. It remains to summarize the various schemes which are recommended in the Provincial Chapters (Part II) of this report; and to frame a construction programme, and a forecast of the expenditure to be provided for if our proposals are generally accepted. For this purpose it will be convenient to assume a period of 20 years; but the actual length of the period, or, in other words, the rate of annual expenditure, will depend on the funds which Government can provide for the purpose, and on the rate of progress which can be attained by the local Public Works Departments. The period for each province can be extended or shortened when these points have been fully considered.

124. We must also premise that we are unable to base a programme on any accurate estimate of the cost of the works which are to be included in it. We have endeavoured, by a study of the records of existing works and of estimates for some new schemes which have been prepared in different degrees of detail, to form some idea of the cost of providing irrigation in those tracts in which irrigation appears to be possible, and in which protection is most urgently required; and also of the probable scope and protective value of the works proposed. Investigations of particular projects have also been undertaken on our recommendations, and reports and detailed estimates relating to them will no doubt be submitted in due course for the orders of Government; but our present programmes and forecasts must necessarily refer to general schemes of irrigation rather than to particular projects. It may be added that the programmes relate only to capital expenditure upon works for which regular capital and revenue accounts will be kept. Whatever expenditure may be incurred in future on minor works, of the kind for which we propose (paragraph 251) that no capital accounts should be kept, will be met from the ordinary minor works grant, and will be outside the programme which we are now considering.

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125. *Classification adopted in forecast.*—It will be convenient to divide all the proposed works in our programme into three classes, which may be called *productive, intermediate,* and *unproductive.* We assume, as we have done elsewhere in this chapter, that a work may be considered productive if it is likely to yield, ten years after completion, a net revenue equivalent to a return of not less than 5 per cent. on the direct and indirect capital outlay. This definition is more convenient for our purpose than the technical or codal definition usually adopted (paragraph 224); and the two will be identical when the accumulated excesses of interest charges over net revenue, at the end of the tenth year after completion, do not exceed one-third of the total capital cost. They should not exceed this in the case of a moderately productive work if, after the work has once been commenced, construction is carried on vigorously until completion. Works that are certain not to pay 5 per cent. have been classed by us as *unproductive;* while works of which it cannot be said with any certainty that they will be either productive or unproductive are treated as *intermediate.*

126. *Punjab.*—The first place among new productive works in the Punjab must be assigned to the Lower Bari Doab project. There is a doubt at present as to the ultimate form which this project may assume; but whether the canal be fed from the Sutlej, involving the construction of additional weirs lower down the river, or from the Chenab, with a feeder from the Jhelum, an expenditure of 600 lakhs is the least that should be provided for. Another 300 lakhs should be added for work on the Sind-Sagar project; and an expenditure of not less than 150 lakhs should be contemplated on the open capital accounts of both perennial and inundation canals, for all of which we have recommended that in future regular capital and revenue accounts should be kept.

127. We have also recommended a moderate expenditure of 50 lakhs on new minor works, such as small inundation canals, for tracts which cannot be included in existing systems. No special or separate provision has been made for new works in the North-West Frontier Province, but part of this sum may be applied to such works.

128. *Bombay; Sind.*—We allow 100 lakhs for extensions of certain canals in Sind, and for improvements of existing works. All this expenditure is likely to be highly productive.

129. *Bombay; Gujerat.*—The most important work that can be proposed is that for a canal from the Sabarmati; but we have been unable to recommend the small project which has been put before us, partly because of the uncertainty of the supply, and partly because its construction might prevent the construction of a work of much larger scope which would be possible if a suitable site for storage works can be found. We have entered 100 lakhs for possible expenditure on this project and the Mahi river scheme, both of which should be investigated as soon as may be practicable; but we do not think that either work will be productive. Without storage they will be very ineffective, and the demand for water will be small. On the other hand, storage will involve a great addition to the capital cost. An expenditure of 20 lakhs may also be allowed for other protective works, such as tanks, which may be proposed in certain parts of Gujerat. We have entered 50 lakhs for a canal from the Tapti which should be constructed if further inquiry shows that there is a fair, although not necessarily an assured, prospect of its proving remunerative. If a sufficient area of rice land can be commanded, the canal may possibly prove remunerative without expensive storage works, the construction of which on the Tapti we are unable to recommend, after full consideration of the circumstances in the Surat district.

130. *Bombay; Deccan.*—We have allowed 600 lakhs for the construction of storage works at the most eligible sites in the Western Ghats, and for canals therefrom into the Deccan districts of Bombay; and 50 lakhs for smaller works and for the completion of some of the storage works on which relief labour has been employed. We estimate that this expenditure will lead to an increase in

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the average irrigated area of about 325,000 acres, which may amount to 500,000 acres in a year of extreme drought. The amount of protection thus provided is of course far from commensurate with the necessities of this famine-stricken tract, but the physical conditions are such that further provision, at any reasonable expenditure, will be wholly impracticable (II, 171).

131. *Madras.*—The three most important works proposed in this Presidency are the Tungabhadra project, the Kistna project, and the proposed storage work on the Cauvery or one of its tributaries. For the latter, 140 lakhs may be allowed, and there is reason to suppose that it will be a productive work. We would also propose an expenditure of 100 lakhs, to be charged against the open capital accounts of existing works, to provide for such works as the improvement of the Kurnool-Cuddapah Canal, the Divi Island pumping scheme, and the provision of additional storage on the Periyar, Rushikulya, and Srivaikuntam projects. We assume that three-fourths of this expenditure will prove remunerative, while one-fourth may be classed as intermediate. We would also propose a further expenditure of 100 lakhs on new storage works of moderate size, of the kind hitherto classed as minor works for which capital and revenue accounts are kept. We think that half this expenditure is likely to be fully productive, while the remainder will fall into the intermediate class.

132. From the information laid before us regarding the Tungabhadra project, we can hardly hope that it will prove a productive work, although it is urgently needed for protective purposes. It is possible that, in spite of its great cost and the doubtful character of the demand for irrigation, it may in time prove less unremunerative than many of the works proposed in Bombay and the Central Provinces, but we cannot at present classify it as anything but an unproductive work. We can form no idea of the ultimate cost of the complete project, which will depend mainly on the storage that can be arranged for; but for the purpose of a forecast we allow 600 lakhs for expenditure within the next 20 years.

133. We have also included 600 lakhs for the proposed Kistna storage work, although it may be doubted whether it could be undertaken in addition to the other works during the period assumed. It may, however, possibly take the place of some of them. After it has been more fully investigated, a better opinion can be formed as to its probable cost and the place to be given to it in a construction programme. It is thought that it may prove a productive work, but we consider it safer to class it as intermediate.

134. *Central Provinces.*—The works proposed in these Provinces are not likely as a whole to be productive, but there may be exceptions, especially in the case of river channels, or such works as the Ramtek project. We would, however, propose an expenditure of three hundred lakhs for the whole period.

135. *Bengal.*—Although unable at present to form any opinion as to the feasibility of the proposed Karamnassa scheme, we allow 90 lakhs for it in our forecast, as we consider that if possible something should be done for the protection of the Bhabua Sub-division of the Shahabad district. We can hardly, in the light of past experience in Bengal, suppose that the work will be other than unproductive; but it is possible that it may in course of time yield a net revenue sufficient to cover the charges for interest on its cost, just as we think the Sone Canals might now be made to do. For works in North Bihar we have allowed a sum of 80 lakhs. We doubt if a large sum can be spent on irrigation works in this tract, as long as the people are unwilling to take or pay for the water except during periods of drought. We have recommended a systematic expenditure of about 1 lakh a year in Chota Nagpur on petty works for conserving the water-supply of the country. These works will not be wholly unremunerative if they receive credit for the enhancement of rentals in Government lands which may be expected to ensue on their construction. We have, in addition, made a provision of 30 lakhs for expenditure on the open capital accounts of existing works. It is doubtful if it will be fully productive.

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136. *United Provinces.*—In the United Provinces the only expenditure which is certain to be productive is that which will be incurred against the open capital accounts of existing productive works; for this 50 lakhs have been allowed. Provision is made of 100 lakhs for a modified Sardah project; but we cannot regard this as certain to be productive, and have classed it as intermediate. For the Ken Canal, and other new works in Bundelkhand and other tracts south of the Jumna river, 90 lakhs have been allowed. The whole of this may be regarded as unproductive outlay.

137. No provision has been made for any expenditure that may be incurred in diverting the waters of the Sardah and Ganges rivers, for the purpose of setting free a share of the Ganges and Jumna supplies for the proposed Eastern Ganges Canal, and for the protection of the insecure tracts in and adjoining the district of Hissar in the Punjab. Our only reason for omitting provision for these important proposals is that at present our information is quite insufficient to admit of even a rough estimate being framed of their probable cost or of the areas which may be brought under irrigation. We do not, however, think that the proposals should be allowed to stand over indefinitely. We regard it of great importance that the question of utilizing the unfailing supply of the Sardah, in those tracts in which it will have the greatest protective value, should be thoroughly investigated with as little delay as possible, and that, if a satisfactory project can be prepared, it should be included in the detailed provincial programme.

138. *General.*—Some allowance must be made for the cost of investigating projects which are not afterwards proceeded with, and for small works in other administrations such as Berar, Coorg, Baluchistan, and British Rajputana. For this we have entered 80 lakhs, which will be generally unproductive.

139. *Abstract.*—The forecast of expenditure for each province may now be abstracted as below :—

Area to be irrigated in thousands of acres.	Province.	Forecast of expenditure in lakhs of rupees.			
		Productive.	Intermediate.	Unproductive.	Total.
2,600	Punjab . . .	1050	50	...	1100
400	Sind	100	...	...	100
170	Gujerat	...	50	120	170
325	Deccan	...	...	650	650
1,925	Madras	265	675	600	1540
450	Central Provinces . .	...	...	300	300
200	Bengal	45	45	130	220
400	United Provinces . .	50	100	90	240
30	General	...	...	80	80
6,500	Total .	1510	920	1970	4400

We have indicated the area likely to be irrigated for the expenditure proposed, but this can only be very roughly estimated at present. The table does not include Burma, nor the expenditure to be incurred on works in other provinces which have already been sanctioned and are in progress. The period of the forecast may, therefore, be regarded as commencing about two years hence,

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when most of the works now in progress will have been completed and detailed estimates of many of the new projects will probably have been considered and sanctioned.

140. *Net cost to the State.*—Taking a return of 5 per cent. on the capital outlay as the standard of a productive work, we may assume an average return of 6·25 per cent. on those which we have classed as likely to be fully productive; and allow for works of the intermediate class an average return of 3·75 per cent., and one of only 1·25 per cent. for works which are classed as unproductive. The direct financial loss on the works as a whole would then stand as follows :—

Lakhs.		Percentage.	Annual profit. Lakhs.	Annual loss. Lakhs.
1510	Productive at . . .	6·25 — 5·0 =	18·88	...
920	Intermediate at . .	5·00 — 3·5 =	...	13·80
1970	Unproductive at . .	5·00 — 1·0 =	...	78·80
		Total .	18·88	92·60

There would thus be a net loss of 73·72 lakhs, as a set-off against which the finances will be relieved by the reduction in the future cost of famine which will result from this expenditure. If it were possible, in sanctioning protective works, to be guided by the principle which we have suggested, that the net burden which the expenditure would impose on the State should never exceed three times the amount of expenditure on famine which would be averted by the works, we could safely estimate the reduction in the cost of famine, due to the construction of works of the intermediate and unproductive classes, at a great deal more than one-third of 92·60 lakhs, that being the proportion in the worst or most unfavourable cases only. As a matter of fact, it is of course impossible to determine accurately either the direct cost of future famines, or the effect of every acre of irrigation in reducing that cost. But, if an attempt were made to regulate sanctions in accordance with some such principle as that which we have proposed, we might fairly assume that at least one-third of the net cost of the works, or say 31 lakhs per annum, would be covered by a reduction in the direct cost of famine, and that the permanent charge on the State would be reduced to about 43 lakhs. We have not, however, considered the saving in the cost of famine which will be caused by the productive works, as we have no means of measuring this. The actual saving in cost of famine relief will not be very large, because most of these works will be constructed in tracts which do not suffer from famine. The cultivation on these works will, however, reduce the cost of famine indirectly in other ways, by increasing the available food supply of the country, and by attracting labour from adjacent distressed districts. The net burden on the State will, therefore, be a great deal less than forty-three lakhs; but it will be further reduced by the share in the increase of the wealth of the community which will accrue to the State indirectly in all years, and also by some reduction in the indirect cost of famine. The residual burden, whatever it may be, will represent the cost to the State of preventing distress within the areas to be protected, instead of providing relief when it occurs—relief which is almost necessarily restricted to the bare protection of human life. It is not for us to propose any final limit to the expenditure which may be legitimately incurred with this object; in which are involved not only the credit and good name of the State, but also the well-being of the millions who, in all but the most unfavourable years, add to its revenues and to the wealth of the country by the precarious cultivation which they carry on in these unprotected tracts. We cannot but think that the programme which we now put forward will not, if our calculations are even approximately correct, impose an undue burden on the State. But our main purpose is rather to indicate what that burden is likely to be, than to offer an opinion as to the limits beyond which the State cannot be expected to go.

141. *Detailed provincial programmes.*—This programme must be regarded merely as an outline. We have endeavoured to distribute the proposed expenditure between different provinces in accordance with what we conceive

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to be the requirements and capacities of each; and as it can never be said in what part of the country famine may next occur, we think that protective operations should be undertaken, in accordance with some definite scheme, in all provinces. If our proposals are favourably regarded, we would suggest that each Local Government and Administration be invited to submit its own programme, which will be prepared on the same lines, but in greater detail and not necessarily so as to work up to the amounts which we have proposed. It will then be possible to prepare a revised general programme, in accordance with which future financial arrangements will be framed. When the provincial programmes have been accepted, Local Governments should be held responsible for their being systematically and fully worked up to, material deviations from the prescribed plan being made only with the sanction of the Government of India. We consider it also of the greatest importance that when the commencement of a work has once been sanctioned, progress should never be interrupted for want of funds. The local officers should be encouraged to complete the work as quickly as may be possible, and the commencement of other works should not be sanctioned if this will involve any diversion of the grants required for works in progress.

142. *Slow construction of irrigation works.*—In connection with these provincial programmes there is a limitation to the rate of progress which must always be borne in mind in comparing forecasts of expenditure on new irrigation works and on railways. The annual outlay on canals can never equal that which has been attained in the construction of railways, the greater part of the cost of which is incurred on permanent-way, iron work for bridges, fencing, etc., and rolling-stock. The earthwork forms a minor charge. When it is desired to push on a railway very fast, it is only necessary to call for more tenders for iron and steel plant, and the markets of Europe and America can meet the supply with little delay. On an irrigation work, on the other hand, almost the whole outlay is on account of earthwork and masonry works, the progress of which depends to a great extent on the local supply of labour. Thus, we have contemplated spending on new irrigation works in the Deccan the sum of six hundred lakhs, but we have been told that an outlay of 25 lakhs per annum would exhaust the labour available in the neighbouring districts. We have no doubt that it will be possible to attain a higher rate of progress than this, if establishments are suitably strengthened, and if Government will commit itself to a continuous policy of irrigation extension, which will induce private enterprise to import labour. But, even allowing for this, the same rate of progress will never be possible on irrigation works as can be attained without difficulty in railway work, on which six crores could be spent in a few years. This facility of rapid construction is one of the many advantages which tend to make railways most valuable protective works. Much more time is required not only for the actual construction of irrigation works, but also for the preliminary investigations and detailed designs; but, on the other hand, the outlay incurred is spent almost entirely in the districts which the works are intended to protect.

143. *Present programme not exhaustive.*—We should add that the programme which we put forward must not be regarded as exhaustive. We do not propose to limit future expenditure on irrigation works to 44 crores of rupees, nor do we consider that irrigation cannot be extended, by new State works, to a greater area than $6\frac{1}{2}$ million acres, so long as the condition that they must be directly remunerative is set aside. But we have thought it better to submit a definite programme for a limited period, than to consider all the unexhausted possibilities of irrigation. If some such programme can be carried out within the period proposed, we have no doubt that by the time it approaches completion other projects will be forthcoming, and a new programme will be prepared. But, although much may then remain to be done, we cannot but express an opinion that the limits to the area which can be protected by State irrigation works at a cost which will not be prohibitive, will then be within sight. Even now there are many areas which such works cannot reach, or which have been, or may be, more effectively or economically protected by other means which we shall now proceed to consider.

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CHAPTER V.—PRIVATE IRRIGATION WORKS.

SECTION I.—GENERAL REMARKS.

144. *Importance of private works.*—We now approach the subject of irrigation from private works; a subject to which our particular attention has been directed in the orders of reference, and which must be regarded as at least equal in importance to that of irrigation from works constructed or maintained by the Government. For, as we have already shown, more than half of the existing irrigation depends on works made or owned by private individuals, and there are vast tracts of country which in the absence of such works could not be protected against the effects of drought.

145. *Classes of private works.*—Private works consist of canals, tanks, wells, and 'other sources,' under which term are included chiefly small channels taking off from rivers and streams and provided frequently with dams—generally small, inexpensive, and temporary. The total area irrigated by private works is returned at roughly 26 millions out of the total of 44 millions of acres under irrigation of all kinds. Out of the 26 millions, about $1\frac{1}{4}$ are irrigated from canals, $5\frac{1}{4}$ from tanks, 13 from wells, and over 6 millions from other or unclassed sources. These figures, however, do not include large areas which are annually watered by river floods. Nor do they include the many thousand acres which, though not directly irrigated in the ordinary sense, are artificially saturated by rain water held up behind or impounded within field-embankments, large and small. Extensive areas of rice and wheat depend wholly upon the water conserved in this way. In the Central Provinces, where alone any record has been kept of the areas so treated, 600,000 acres, almost wholly under wheat, are embanked. It might have been doubted, perhaps, whether the subject of field-embankments was within our reference. But we have had no hesitation in dealing with them as one of the most important, and in many places the only, means of conserving in the soil, water essential for the protection of the country in dry seasons.

146. *Private canals.*—Private canals are found chiefly in the Punjab, Bengal, and Upper Burma. In the Punjab they irrigate about a million acres in a favourable year, and in Upper Burma 300,000 acres. In Sind, a large area is shown in the annual returns as irrigated from private canals, but in all or nearly all cases, these are merely private water-courses taking off from Government canals. In Bengal, where there are no annual records of areas irrigated, the large area irrigated from small private canals is shown under 'other sources' in the estimates which have been supplied to us. The private canals in the Punjab are fully treated in the chapter upon that province. Here it is unnecessary to say more than that, generally speaking, while it is inexpedient to discourage the making of private canals in tracts where Government is not ready to take up such works, it is rarely advisable to offer any special encouragement for this purpose. Works of such magnitude as to be dignified by the name of 'canals' should, as in Egypt, with rare exceptions be constructed and maintained by Government in the general interests of the public. Individual owners, who would usually be natives of India, are seldom able to provide the capital or skilled direction required, and there are many reasons why it is unadvisable to entrust the development of large irrigation schemes to the agency of public companies. In support of this proposition, it is sufficient to observe, that in the only instances in which canals have been made by companies, they have proved conspicuous failures, and it has been found necessary for Government to acquire the concerns. In India, the canal revenue and the land revenue are so closely connected as to make it essential for the administration of both to be in the hands of one authority. For a company to manage with any chance of success a large irrigation scheme, it would be requisite that it should be made proprietor of the land commanded. But there is no case in which Government would be justified in conferring such a status

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on a company, except perhaps where the tract to be brought under irrigation consisted entirely of crown waste. But the most remunerative projects for irrigation of such tracts have already been taken up by Government and are being administered with great success. The remaining projects of this kind are few, and they would require for their development extensive colonization from congested tracts. There would be an uncertain chance of their yielding such a return as would satisfy a body of private capitalists, and they are most likely to succeed if managed by the same agency and on the same lines as the existing systems.

147. *Tanks.*—The tanks of India generally consist of reservoirs or lakes made by throwing dams across valleys and streams. In this category, however, are included *jhils*, or natural depressions, which are scattered at intervals over the flat alluvial plains of the United Provinces. The areas irrigated from tanks, both State and private, are distributed as follows:—

	Acres.
Punjab	30,000
Madras	5,019,000
Bombay	192,000
United Provinces	2,093,000
Central Provinces	594,000
Upper Burma	174,000
Ajmer-Merwara	36,000
Total	8,138,000

148. Most of the tanks in Bombay, Upper Burma, and Ajmer-Merwara, belong to Government; as do those in Madras outside the *zamindari* tracts. In the United and Central Provinces they are, generally speaking, privately owned. In Bengal, also, there is a considerable privately owned area of tank and *jhil* irrigation of which at present there are no separate returns. Excluding Bengal, the irrigation from private tanks may be taken roughly at about $5\frac{1}{5}$ millions of acres as against about 3 millions irrigated from tanks belonging to Government. The irrigation is generally by flow from a tank proper. But in the Central Provinces considerable areas are supplied by percolation; and in the United Provinces the irrigation from *jhils* is nearly always by lift. In a year of actual drought there is naturally a great decrease in the area irrigated from tanks. Thus in the United Provinces in 1896-97 the area fell to under a million acres, and in the Central Provinces in 1899-1900 to barely 176,000 acres. But when, as is more frequently the case, the rain, though ill-distributed or insufficient to mature the unirrigated crops, is sufficient to fill the tanks, they are of the greatest value. Thus in 1896-97 in the Central Provinces, where the rainfall was normal in amount although it ceased so early as to ruin the unirrigated crops, 648,000 acres received water from the tanks. Similarly in the United Provinces in 1899-1900, when the autumn rains were excessive at the beginning but scanty towards the end of the season, the tanks supplied water to 2,273,000 acres.

149. In years when the rainfall is both abundant and tolerably well-distributed, there are many tracts in which the tanks may be comparatively little drawn upon. But throughout the tracts where tanks exist, experience has shown that, even when the rainfall is considerable, there is hardly a single year in which the tank water has not been found useful. Private tanks vary considerably in capacity, but they are seldom so large as to place their construction and management beyond the resources of a single proprietor. On the other hand, as has been found in Madras, and even in Bombay where tanks are far less numerous, it is very difficult for a Government Department to construct, maintain, and superintend, the management of a large number of these small works scattered over a considerable area. The assistance of Government can best be given by loans and grants to supply the funds required for construction, improvement, or extensive repair; and by professional assistance in the selection of sites, in the supply of designs for the larger works and for such useful appurtenances as sluices, outlets, and escapes, which serve to increase the efficiency of irrigation, and prevent breaks-down and breaches

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when the works are subjected to abnormal strain. The greatest scope for the extension of private tank irrigation is to be found in the southern and western portions of the Central Provinces, the southern and eastern portions of the United Provinces, such as the Jhansi and Mirzapur districts, and in parts of the Shahabad, Bhagalpur, and Bankura districts, Chota Nagpur, and the Sonthal Parganas of Bengal. It will, however, be a difficult task to induce the zamindars to do much for themselves in this matter; and where, as is frequently the case, the existing tanks are out of repair or ill-provided with subsidiary works, endeavours should, at the commencement at any rate, be concentrated upon the task of getting these defects remedied. The time for a step forward in the matter of extension will probably be the first severe drought, when, besides inducing the proprietors to do all that they can, Government will be able to give the aid of famine relief labour.

150. *Other sources of irrigation.*—Rivers and streams, and channels leading from them, account for the bulk of the irrigation from 'other sources,' which is distributed as follows:—

	Acres.
Punjab	160,000
Bombay	140,000
Sind	110,000
Madras	23,000
Bengal	4,945,000
United Provinces	685,000
Upper Burma	98,000
Central Provinces	23,000
Berar	2,000
Total	6,186,000

The figure for Bengal includes a large area which is irrigated from rain-fed or stream-fed tanks, in addition to a very large area irrigated from river channels. The greatest development of this latter form of irrigation is found in the district of Gaya, where a system of small canals known as *pains* was made in the time of the Tikari Raj. Some of the channels irrigate as many as two hundred villages. In the famine of 1896-97 temporary channels were opened out by the Rajah of Darbhanga in the north-east of the district. Further west, too, in the submontane tracts of the district of Ghazipur in the United Provinces, Messrs. Peppé and Holdsworth have constructed on their estates a network of irrigation channels leading off from permanent dams. It is probable that throughout the submontane tract at the foot of the Himalayas irrigation is capable of considerable extension by means of these small works. For, although the rainfall is copious, it is so variable in its distribution that there are few years in which irrigation is not useful; and, by supplying it, the landowner gets far better security for his rents, even if he does not obtain any enhancement of their nominal amount. We have cited separately (II, 364) the figures of this class of irrigation in the Central Provinces in order to draw attention to their smallness. But in these Provinces the scope which exists for irrigation from channels in years like 1896-97, when the rivers are full but the rain stops early, is shown by the expansion of the irrigated area in that year from the average of 18,000 up to 52,000 acres. There can be no doubt that irrigation from these sources might be largely extended in these Provinces with advantage. In this class of work, there is special scope for professional expert aid in the alignment of channels, the choice of sites for their heads, the design of suitable head-works, regulators, and the like. Some of the existing channels, especially in the district of Gaya in Bengal, are in extremely urgent need of these improvements. In such cases it may be advisable to bring considerable pressure to bear upon the landlords to execute them, and in all cases it will be worth while to give liberal assistance by *takavi* or grants, according to circumstances. There are also cases in which the construction of these channels will be a very useful form of famine relief work.

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151. *Maintenance of private irrigation works.*—The works of these three classes—private canals, tanks, and channels—have frequently been allowed to fall into disrepair so serious as to diminish largely, and in some cases even destroy altogether, their efficiency. The fault lies partly with the owners and partly with the tenants, on both of whom the obligation to perform certain classes of repair has been placed by immemorial custom, sometimes confirmed by statute law, and generally entered in records-of-rights where such records have been kept. Usually it is the business of the landowner to repair breaches, and maintain outlets and regulators, so far as may be required for the distribution of water from the main work and distributaries. The duty of the tenant is generally to keep in order the minor water-courses leading from the main channels, and to effect other small repairs, such as the clearance of silt, the filling up of rat-holes, the clearance of vegetation on the tank *bands*, and the like. There is a customary obligation, also, on the cultivators of land irrigated from any work, to turn out themselves or provide labour to cope with serious emergencies, such as a sudden breach or flood. We have found in some provinces the need of a clearer definition of these obligations, and of stronger authority to enforce them; and we have made in our Provincial Chapters recommendations suited to local conditions. We have also proposed that when repairs required on any work are so expensive as to be beyond the resources of the landowner he should be granted loans, and even free grants-in-aid. Unless such aid be freely given when required, no useful end will be attained by placing legal pressure upon the landowners.

152. *Field embankments.*—Excepting wells, there is perhaps no class of land improvement which is more extensively employed, or more useful than those which we have included under the generic term 'field-embankment,' which comprises the following two classes of works :—

(i) Embankments proper, known as *bands* or *bandhias* in the Central Provinces, *bands* in the Punjab and United Provinces, *áhars* in Bengal, *bándhs* in Gujerat, and *táls* in the Bombay Deccan. In broken country these works consist of dams across ravines or the beds of small streams and water-courses; and, in flatter country, of areas embanked on one, two, three, or even four sides, the banks being of widely varying height and dimensions, from the low bank which encloses a rice field, to the high and long embankments which enclose many acres of wheat in the Central Provinces. In these latter Provinces, and in Bundelkhand (United Provinces), field embankments are found to be of special value in eradicating the noxious weed-grass known as *káns*, which succumbs to the complete and continuous flooding given by water held up within the embankments.

(ii) The terracing and levelling of sloping lands, with the object of preventing erosion of the soil and conserving moisture in it.

153. Generally no hard and fast line can be drawn between the two classes of works, as the damming up of a dry water-course or drainage depression results in the accumulation of silt and soil till the terrace is formed; and a succession of terraces is often formed by a series of *bands*. By means of these works many acres of land have been rendered fit for cultivation, and capable of withstanding the effects of drought, in most unpromising tracts of country, such as the barren uplands of the Bombay Deccan and Central India. In more fertile tracts also, they render possible the cultivation, in the *rabi* season after the close of the monsoon, of the more valuable wheat crop in place of the less valuable millets and other monsoon crops. In South Bihar (Gaya, Patna, Shahabad), Chota Nagpur and elsewhere in Bengal, and in the Mirzapur district of the United Provinces, they secure the rice crop against the vicissitudes of ill-distributed rainfall. In hilly situations cultivation is generally impossible without terracing on an extensive scale, and 'bunding' occurs extensively in most submontane tracts. Ravine lands occur mostly near the banks of the large rivers traversing the great alluvial Gangetic plains. An excellent example of reclamation of such land is to be found on the Government Dairy Farm at Allahabad. But, with regard to the

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immediate purposes of our inquiry, the main value of the embankment consists in the prevention of the escape of rain-water until the soil has been thoroughly saturated, in the permanent storage of moisture, and in the consequent raising of the subsoil water level to the benefit of well-irrigation in the vicinity. In some cases, as in the Central Provinces, the size of these embankments might be sufficient to justify their occasional construction by Government in ordinary years. But in the great majority of instances, the work had best be left to private enterprise, for which it is peculiarly well suited. A good deal of money has been advanced for this purpose in the Bombay Presidency, both in ordinary years and in years of famine. Substantial sums were given also during the famines in the Central Provinces. These embankments have also been made with considerable success as relief works in the State of Gwalior, where we saw several satisfactory instances of land reclaimed, or in the process of being reclaimed, by their means. Relief was also employed on them in Bundelkhand, in the Central Provinces, and in the Bundelkhand States. They are likely to be useful in many tracts of black soil where direct irrigation would not be suitable. In the various Provincial Chapters we have recommended that strong encouragement should be given in ordinary years to the construction of these works, by liberal *takavi* advances, and by free grants in tracts exposed to famine; and that in districts where their construction is likely to be of use, famine labour should be extensively employed on them.

Section II.—WELLS.

154. *Numbers of wells and areas irrigated.*—The great importance of wells as sources of irrigation may be gathered from the fact that they supply water to more than one-fourth of the total irrigated area, and to nearly one-half of the total area irrigated by private works; and their immense value in years of drought, from the fact that in the famine year of 1896-97, the area under well-irrigation rose at once by nearly two and a half million acres, while that under tanks fell by nearly one and a half million. And again in 1899-1900, notwithstanding that in many parts the well supply had begun to fail owing to the succession of dry years, well-irrigation rose by more than a million acres, while irrigation from tanks diminished. Some of the most interesting statistical facts relating to well-irrigation are summarised in the following table:—

Province.	Number of wells used for irrigation.			Gross area irrigated in a normal year.		Percentage of gross cropped area under well-irrigation.
	Permanent.	Temporary.	Total.	Total.	Average per well.	
	No.	No.	No.	Acres.	Acres.	
Punjab . . .	275,000	74,000	349,000	3,750,000	10·7	13
United Provinces .	500,000*	830,000	1,330,000	5,731,000	4·3	14
Madras . . .	626,280	...	626,280	2,000,000†	3·2	5
Bombay . . .	254,000	...	254,000	650,000	2·6	2¾
Central Provinces .	14,000	42,000	56,000	77,000	1·4	½

155. *Wells in Northern India.*—The above figures relating to the distribution of well-irrigation are exceedingly striking. Out of a total of 13 million acres irrigated from wells in British territory, no less than 9½ millions are found in the two Northern Provinces. In the Central Provinces there is next to no well-irrigation. South of this there are some 2¾ million acres, of which roughly three-fourths are in Madras and one-fourth in Bombay. This distri-

* Includes 170,000 half masonry wells. † Includes the area irrigated from tanks assisted by wells.

Note.—Separate figures for permanent and temporary wells are not available for Bombay, and no information as to the number of wells is available for Bengal. The figures for Madras include both *rayatwari* tracts and *inam* villages, but do not include *zamindari* areas for which no information is available.

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bution of well-irrigation is, of course, far from accidental. The most favourable conditions are found in the alluvial plains of Northern India, the subsoil of which contains an inexhaustible supply of water. Here, throughout a broad zone of the plains, water is usually to be found close to the surface, and a well can be sunk through soft and pervious strata until it reaches a bed of firm clay which forms an excellent foundation. By penetrating this bed, which is generally of slight thickness, by a boring of a few inches in diameter, a porous substratum is reached, the water from which rises into the main cylinder of the well, and gives a supply sufficient to irrigate very considerable areas. In the Punjab, where the great bulk of irrigation is carried on from permanent wells, the area irrigated by each well averages as much as 11 acres, while in some of the districts double that area is watered from a single well. There are individual wells which water as much as 50 acres. In the United Provinces also large areas are watered from permanent wells. But in addition there are many thousands of temporary wells. The numbers of such wells in use in these Provinces, and the areas irrigated by them, fluctuate largely with the character of the seasons—rising in dry and falling in wet years. In the famine year of 1896-97 the cultivators are reckoned to have dug 550,000 of these wells. In 1899-1900 the number of temporary wells was 1,092,000. In the next year it sank to about 834,000, and in one wet year it did not exceed 628,000. The area irrigated by them is small, not more on the average than 2 acres at the outside, but they cost little or nothing. In these Provinces also frequent use is made of what is known as the half-masonry well, which consists generally of a cylinder of sun-dried bricks uncompacted by cement of any kind. The cost of these wells is frequently trifling, but some of them last for years.

156. *Wells in Peninsular India.*—South of a line which may be taken as that of the Jumna river produced through Allahabad to the east and Agra to the west, there are few places where at all comparably favourable conditions for well-irrigation prevail; although to a certain extent they are found in the low-lying belt of alluvial soils on the west coast of Gujerat, and the east coast of Madras. But this has not prevented the digging of a large number of wells, to the construction of which an immense stimulus was given in the years of famine and drought. Thus in Bombay, where there are comparatively few temporary wells, the permanent wells approach in number those of the Punjab; and in Madras, where all the wells are said to be permanent, there are more wells of this class than in the United Provinces, and twice as many as in the Punjab. But the best wells of Madras and of the Bombay Deccan are generally sunk in hard ground with a foundation of rock, or in the rock itself. In the extensive black soil tracts, irrigation from wells hardly pays except for very high class crops, and then only when the soil is not deep and overlies a permeable stratum of lighter soil. Often in the black soil the subsoil water lies at a great depth. On the coast, too, the water-supply is apt to be treacherous both as to quantity and quality. In the Central Provinces wells of all kinds are few in number, and permanent wells exceedingly few.

157. *Comparative efficiency of wells in Northern and Peninsular India.*—It will not have escaped notice that it takes four Madras or Bombay wells to irrigate the same area as one well in the Punjab. But this does not give a correct idea as to the relative efficiency of the wells. In the latter province the wells irrigate extensive areas of cereal crops without any very special or high cultivation. With the cold winter climate of Northern India, and the rich alluvial soils, highly retentive of moisture, very few waterings are required to bring the crop to maturity. Considerable reliance also is placed on the winter rains, which seldom or never wholly fail. In the Peninsula the conditions are very different. Throughout the year the climate is warm and the sun powerful. Frequent waterings are necessary to mature the crop, and it rarely pays to irrigate from wells without the expectation of a very heavy outturn of cereals, or of some specially valuable crop such as sugarcane or garden produce. Highly intensive cultivation and heavy manuring are required. In Madras, it is true, a number of small wells are made mostly for the purpose of supplementing

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irrigation from tanks, the supply from which is precarious, and these wells are used to mature the winter rice and for the rearing of seedlings of the later varieties. But those wells which are used for high cultivation frequently produce by repeated cropping a much larger area than would be inferred from the figures of area irrigated. The value too of the produce obtained must be at least as great as, and in many instances greater than, that obtained from the large areas irrigated by the wells in Northern India.

158. *The Central Provinces.*—In the Central Provinces, as the figures show, the total area irrigated by wells is insignificant, and the total number of permanent wells is little more than nominal in relation to the cultivated area. It is to be feared that physical conditions are somewhat unfavourable for well-digging in these Provinces. The eastern rice districts resemble to some extent Bengal, in the rice tracts of which wells are exceedingly rare. In the rest of the Central Provinces conditions would seem more closely to resemble those of Bombay, where more than four times as large a proportion of the net cropped area is irrigated. The neglect of well-irrigation in the Central Provinces is probably attributable to the sparsity and backward character of the population in many parts; the unfailing abundance, until recent years, of the rainfall; and the existence, until recently, of large areas of good but uncultivated land, to the reclamation of which the energies of the people have been directed, rather than to the intensive cultivation of the more valuable soils.

159. *Bengal.*—With regard to Bengal, although the statistical information is partial and meagre, we have been able to ascertain that, except in the west of Bihar, there is little or no well irrigation. Eastern Bengal is a vast sheet of unfailing rice crops, and despite the teeming population, there is no need for intensive cultivation or for irrigation of any kind. In the rice districts of Bihar the crops are subject to failure, occasionally extremely wide-spread and severe. Wells, nevertheless, are little appreciated. They would probably be of small use for the saving of the rice crop, which requires far more water than they could give; and in ordinary years the rainfall is so ample, and the moisture retained in the soil so abundant, that large areas of sugarcane can be grown without the aid of artificial irrigation. In many places also, owing to the loose and sandy character of the soil, the construction of wells is difficult and expensive.

160. *Diversity of local conditions.*—As will have been partially gathered from what has been stated above, the extent of well-irrigation varies little less within the limits of each province from district to district, or even from one part of a district to another, than between one province and another. Thus in the south-eastern districts of the Punjab, the subsoil water lies at great depth below the surface; wells accordingly are few in number, and the areas irrigable from them are comparatively small. In such districts as Jullundur and Sialkot, on the other hand, there is a permanent well to every 20 or 30 acres of net cropped area, each well irrigating at least 6 acres. Similarly in parts of the Bundelkhand districts of the United Provinces, where the subsoil is rocky or black cotton soil prevails, wells are few and the water difficult to get; whereas in some of the Oudh districts, 30 to 40 per cent. of the net cropped area is irrigated from wells. In Madras and Bombay, wells are generally speaking most numerous on alluvial soils on the coast, and in the districts or parts of districts adjoining the mountain ranges; for instance, in the Madras district of Coimbatore, there is generally a permanent well to every 30 acres of cropped area and each well irrigates 5 acres. On the other hand, wells are almost non-existent in the great black soil plains, whether inland or on the coast.

161. *Modes of construction.*—Wells differ of course widely in their mode of construction. In the alluvial soils of Northern India and the coast line, a permanent well consists of a brick work cylinder, resting on a wooden kerb which is sunk into the subsoil by excavating from below, and by utilizing the excavated material to add weight to the well and assist it in sinking. A temporary well is a mere hole lined with wattle or wood work. In Peninsular India, where, as in Bundelkhand and the Deccan, the rock is often near the

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surface, the well is a round or square excavation, 20 to 100 feet or even more in width. The excavated rock is utilized to line the sides of the well. In some cases all four sides are lined; in others only so much as is required as a staging for the lifting gear. With ordinary attention a well of this class will last for an indefinite period, while even the best built well in an alluvial soil will fall in in process of time.

162. *Cost of construction and working.*—The expense of construction varies with the conditions of soil, subsoil, and water-level. Temporary wells in adhesive alluvial soils, where they are little more than holes in the ground, can be made for a few rupees and form an ordinary incident in the expense of cultivation, being often renewed annually. Where the soil through which the shaft of the well has to be sunk is loose, or where hard rock is encountered, or the water lies deep, heavy expenditure may be required. In such conditions, only permanent wells will pay; and they only when there is a certainty of an abundant supply of water sufficient for the irrigation of a considerable area, or for the maturing of abnormally heavy or valuable crops on small areas. The cost of such wells runs into hundreds or even thousands of rupees. It is hazardous to give any sum as the average cost of a well, the variations are so great. But the following figures may be taken as a rough indication of the cost of construction, in some of the principal provinces, of a permanent well capable of irrigating the average area with water at the average depth: Gujerat, Rs. 500 to Rs. 700; Punjab and United Provinces, Rs. 300; Central Provinces, Deccan, and other districts with rocky subsoil, Rs. 300 to Rs. 400. It would be fairly safe to say that the capital cost of a permanent well in Northern India would be seldom more than Rs. 40 per acre irrigated. In Southern and Central India it would seldom average less than Rs. 100 per acre; except in the tracts where the semi-permanent well can be used, when the cost would run between Rs. 60 and Rs. 80 per acre.

163. The expenses of labour, cattle, and plant, required for working a well also vary greatly. A large well may require four or even six teams of bullocks, with two, and sometimes four, animals to a team. For animal power, employment is made of the Persian wheel or the well known water-bag. On many of the large temporary wells, and generally on all the semi-temporary, animal power is employed. But there are numerous small wells in Upper India, Bihar, and Madras, from which the water is raised in pots or small bags by manual labour working with a wheel or a weighted lever. Wells of this kind are frequently worked in groups, all supplying the same water-course.

164. The quantity of work which can be done on a well varies immensely with the season, the area to be irrigated, and the character of the crop. It is almost impossible, therefore, to arrive at any satisfactory estimate of the cost of irrigation from a well, for such purposes for instance as comparison with the cost of irrigation from a canal. But there can, of course, be no manner of doubt that well-irrigation is by far the more expensive process of the two, except perhaps when water lies so close to the surface that irrigation can be done by means of the lever. To arrive at even a tolerable estimate, the most elaborate and careful experiment is required. The only set of such experiments with which we are acquainted are those of Captain Clibborn published in his report on well-irrigation in the United Provinces. Here, the irrigation of a crop of wheat, with the mean water level at 30 feet, is shown at Rs. 7 per acre; and this is doubtless the lowest figure at which the charge can be fairly estimated. In Southern India the heavy waterings required must largely increase the charge. Thus the irrigation of a crop of barley in the sandy soils of the Ahmedabad district is estimated to cost Rs. 22-8 per acre, and that of garden crops in the neighbourhood of Surat ranges from Rs. 30 to Rs. 60 per acre. (*Mollison's Indian Agriculture, Vol. III.*)

165. *Liability to fail in drought.*—Figures have been given above in illustration of the value of wells in time of famine, owing to the large extensions of irrigation which are made by their means. These extensions are due partly to an increase in the number of permanent wells, but chiefly to greater activity

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in the working of existing wells, and to a large increase in the number of temporary wells. In the great alluvial tracts of Northern India the subsoil water-supply appears to be practically inexhaustible, although the level rises and falls perceptibly in years of heavy and light rainfall. Elsewhere, the supply is generally ample in the first year of drought, but the effect of a long series of dry years is to diminish steadily the area that can be served by each well. The diminution, however, is not wholly attributable to exhaustion of the supply, but to the dryness of soil and atmosphere which necessitates more abundant watering to mature the crops, and to the harder work imposed on the cattle as the lift increases, and the difficulty of maintaining them in good condition owing to the dearth or scarcity of fodder.

166. *Scope and measures for extending well-irrigation.*—It has been shown that well-irrigation varies in extent to an extraordinary degree in the different provinces, and that the variation is principally due to immutable differences of physical conditions. It is, however, certain that there is no single province in which this form of irrigation might not be very largely extended with advantage. Even in the Punjab and United Provinces, in which the largest areas are irrigated, there are tracts very poorly equipped in relation to their capacities. In some districts abundantly equipped, wells are so essential to successful cultivation, and to the maintenance of a dense population, that endeavours to multiply them should be made and sustained until the very maximum numbers have been reached which can be profitably employed. There are also tracts in which water lies so close to the surface that canal-irrigation may be not only unnecessary, but actually harmful; but in which, nevertheless, irrigation of some kind is urgently required in order to get full production from the soil in ordinary years, and to save the crops in times of drought. For such tracts wells are a necessity. In other tracts which depend on inundation canals or tanks of uncertain supply, wells are of immense service in supplementing deficiencies in supply. In all such places the construction of wells should be liberally encouraged. In the two Northern Provinces above mentioned, it may be said broadly that only in special tracts, where wells are required to give protection in famine, would it be justifiable for purposes of such encouragement to incur any great financial sacrifice. Elsewhere, the people may be trusted to increase wells as rapidly as will pay them, without any stimulus beyond the provision of capital on more favourable terms than they can obtain in the open market.

167. In Central and Southern India wells are relatively few, and the areas which can be protected by each well are small. The need for them also is urgent, not only for the increase of production and the support of a dense population, but because they supply the only efficient means of protection against severe and frequently recurring drought in vast tracts, into which, except at prohibitive expense, it is physically impossible to take canals, or if taken, to assure them a supply of water when it is most needed.

168. Thus within two hundred miles of the Western Ghats the provision in the Bombay Deccan of assured irrigation by canal will, according to our estimate, require a capital expenditure of not less than Rs. 200 per acre, out of which the revenue realized will pay interest only on Rs. 50 in addition to working expenses. The net cost to the State will therefore be at least Rs. 150 per acre. In these tracts the people can build wells for themselves for about Rs. 100 per acre. Even, therefore, if the State supplied the whole of the capital required for wells, the financial loss, provided the wells are efficient, would be considerably less than that which would be entailed by the provision of canal-irrigation. For this reason it is perhaps even of greater importance in these tracts, than in Northern India, to avoid taking canals into places which can be equally well served by wells. Here also the State is justified in giving far greater stimulus to well-irrigation, and in making considerable financial sacrifices for the purpose. Not that caution can be dispensed with. The annual rate of increase in the number of wells, although capable of great acceleration, must be gradual. In these parts of India cultivators cannot afford to irrigate in ordinary years unless they obtain large and valuable crops to recoup the heavy expenditure and labour required for high cultivation. Care will have to be taken that money is not

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thrown away on the construction of wells by persons who are destitute of the energy and resource required to work them. But boldness is required no less than caution. The cultivator will have to face risks as well as Government, and Government should not hesitate to take its full share.

169. We have now to consider what special steps Government should take to facilitate the extension of well-irrigation. And first we propose to discuss briefly the suggestion which has been made from time to time that wells should be made by Government, like any other irrigation work, and a revenue levied as a return on the expenditure incurred. The proposal at first sight appears plausible, when considered with reference to tracts mentioned above, in which irrigation from wells entails smaller capital cost than irrigation from canals. It has also been adopted, since the recent famine, on a small scale in many of the Native States, such as Baroda and Gwalior. We are nevertheless clearly of opinion that it must be rejected as unsound. There is scarcely a witness who does not agree that the cultivator is able to make wells for himself much more cheaply, and quite as effectually for his purposes as Government can make them for him. If new wells are to be made in large numbers, they will be dispersed over large tracts of country. For, as already observed, well-construction must be gradual, and operations cannot, therefore, be concentrated on any single tract and there completed before pushing on to the next. The difficulty of superintending the construction and maintenance of a number of small works, scattered over extensive areas, is obvious. Some experience has already been gained of this difficulty in the case of tanks in *rayatwari* districts, where they belong to Government, and their maintenance and repair by Government agency is found extremely difficult. *Per contra*, if wells are made for himself by the cultivator and belong to him, he will be interested in their efficiency and maintain them as long as they pay him. In support of the view that Government should not make wells, may be urged the fact that few even of the most enlightened landowners construct them in the lands of their permanent or occupancy tenants, but prefer that the tenants should make the wells, and to give them assistance in materials if not in money, besides possibly making things easy in matter of rent. In their own lands, the *zamindars*, large and small, construct wells for themselves, just as the occupiers do in *rayatwari* provinces. And there can be no doubt that the cultivators, whether tenants or peasant occupiers, infinitely prefer to make wells for themselves if given the necessary capital and facilities.

170. There is, however, one rare case in which it may be occasionally useful for Government to construct irrigation wells, namely, in places where, notwithstanding that there is a probable scope for well-irrigation, the people out of apathy or ignorance neglect it. As an example of this attitude on the part of the people, we may instance parts of Chhattisgarh, where the people have such a strong antipathy against wells that they even refuse to use them for drinking purposes, when they have been provided for them and no other decent water is to be had. In such cases it may be worth while for Government to build a few wells in order to demonstrate their value to the people. But as soon as any well thus built has proved a success, the land, with the well under it, should be handed over to an enterprising cultivator with the object of getting him to set an example to his neighbours. Even, however, in these cases, it would generally be preferable to get the wells built by cultivators, who might be imported, as the *Káchhis* were imported from Cawnpore to Nagpur, and helped with advances of money and grants of land.

171. It must not be inferred from these remarks that we object to the construction of wells by Government agency in Wards' estates, or in estates managed and owned by Government in *zamindari* provinces. In these cases Government is fully justified in setting, and indeed is under a special obligation to set, an example by executing all such improvements as a good and prudent landlord would undertake. But even in its own estates or in the estates managed by it, Government will often be better advised to get the tenants to make the wells, by giving appropriate help in the way of money, material, and professional assistance.

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172. The chief way in which Government can assist in extending well-irrigation is by liberal *takavi* advances, and free grants in special localities. This part of the subject is so important with respect to all classes of private improvement that we have devoted a special chapter to it. We here add only a few suggestions and observations specially applicable to wells.

173. *Risks to be shared by Government.*—We have said that Government must be prepared to share some of the risks of well-construction with the cultivator. One of the chief of these is the failure to find water. We think that in cases where the cultivator, after taking all due precautions, without any fault of his own fails to find water, he should be allowed a partial remission of the money which may have been advanced to him. We cannot recommend remission of the whole sum advanced, since this would be likely to encourage mere gambling in well-sinking. By the preliminary borings and subsoil water-surveys recommended below, the risk of failure would be greatly diminished, and as soon as sufficient facilities had been provided in any neighbourhood, the making of a preliminary boring should, wherever uncertainties exist, be made a condition precedent to the disbursement of the advance or money-grant. Advances should, of course, be given in instalments, the second being made payable after completion of the work expected to be done out of the first, and so on.

174. Another risk to be shared by Government is connected with the life of the well, which in many tracts is a variable quantity, although in some, wells even when roughly constructed last for indefinite periods. We propose, in the next chapter, a method which will allow the cultivator, for repayment by equal instalments, a period equal to that which is calculated to be the average life of wells in the tract, and the remission of the balance which may be due, if the well should fall in, or become useless from circumstances beyond his control, before the expiry of the period.

175. *Trial borings and subsoil water-survey.*—In many places, notwithstanding the aptitude and experience of the people, uncertainty exists as to the suitability of sites for wells, and as to the possibility of tapping a permanent source of supply which would not be dependent on mere local percolation. To obviate the failures to find water which are not infrequent especially when, as in a famine year, wells are made in a hurry, detailed and systematic surveys should be made of the subsoil water. Over the greater part of the alluvial tract of Northern India the people have a very good local knowledge of the nature of the substrata and of the subsoil water-supply; all that seems to be required in this tract is to render assistance, where necessary, in making trial borings by providing boring tools and expert workers at a small charge; and to have mapped out, from local inquiries, all tracts in which the construction of temporary wells can be usefully pushed at an early stage of a famine. In Peninsular India also there are few provinces in which it would not be useful to provide tools at the head-quarters of most divisions and of some districts and even sub-divisions as well.

176. Endeavours should be made to discover some simple and inexpensive method of boring. With this purpose we have recommended the Government of India to allow experiments to be made with the Kazusa system of boring, which is said to have been found exceedingly cheap and efficient in Japan in tapping artesian supplies. We have, as we shall show, little expectation of reaching artesian supplies. But there are localities such as the south-eastern districts of the Punjab, the South-Jumna districts of the United Provinces, parts of Gujerat, and the trap areas of the Central Provinces and the Deccan, where special experiments in boring may be made with advantage, in order to ascertain whether any deep source of supply can be tapped for irrigation purposes. Successes obtained by boring in rock with jumper bars in the Sholapur district of the Deccan, and by Mr. Tata with his deep borings at Navsari in Gujerat, indicate that from below or within the rocky substrata in the Deccan, and from porous strata underlying the superficial clays and non-permeable soils elsewhere, water may be obtained at sufficient pressure to rise through a bore of small diameter high enough to give abundant supplies to wells of moderate

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depth. The discovery of a method of cheap boring to such sources might result in a large increase of the available supply for wells in tracts where the finding of water has been despaired of up to the present. In these localities careful record should be kept of the results of all borings, and of observations of existing wells. The site of each well or boring should be marked on a plan of the country; and the normal level of the subsoil water at each site, the quality of the water, the nature of the strata, the depth of the boring, and its effect on the level of the water within it, and on the quality and quantity of the supply, should be systematically recorded.

Section III.—Miscellaneous.

177. *Necessity of minute regard to local conditions.*—In our Provincial Chapters we have indicated the localities in which financial concessions may most appropriately be given for the construction and improvement of private irrigation works. We desire to say here that in stimulating improvements of all kinds, and most of all in pushing well-construction, minute regard must be had to local circumstances. The conditions not merely of districts but of sub-divisions, groups of villages, and individual villages, must be ascertained and studied beforehand. For these purposes the Circle Books, which are compiled in every province, should be freely utilized. The irrigational capacities and requirements, the kind of improvement best suited to the locality, the degree of willingness shown by the people to execute improvements either with or without Government aid, the extent of their resources in capital, credit, manure, and labour, should be particularly inquired into, and noted in the books by the district officials when on tour. The facts should be collated, and a programme or plan of campaign should be gradually worked out for each circle in each district. A good example of the way in which the requirements of particular areas should be worked out is given in the reports compiled under the orders of Sir A. P. MacDonnell for the districts of the 'Drought Tract' in the United Provinces. For each circle (or pargana as it is called) the principal local conditions, such as the kind of irrigation which should be given, whether by canals, tanks, wells, or field-embankments, and the percentage of the area which will be protected if the proposals are carried out, have been specially noted, and index maps have been prepared, showing at a glance the character and scope of the proposed operations. We should like to see similar reports and maps prepared for every district and circle. In certain tracts which urgently require prompt treatment, special inquiries should be made by specially appointed officers; and, whenever any tract comes under detailed examination for purposes of revenue settlement, opportunity should be taken to bring the information up to date. In particular, for the extension of well-irrigation, accurate information should be collected regarding the character of the substrata, the level of the subsoil water, and the nature of the supply.

178. *Exemption of improvements from taxation.*—Besides the positive help and encouragement which the State has given in the making of private improvements, there is stimulus of a negative character to which great importance has been and must always be attached. We allude to the exemption of improvements from taxation. In this respect there is an important difference of practice in the various provinces. In Bombay and Madras the exemption allowed is perpetual, whereas in Northern India it is limited to the period calculated as sufficient to enable the executor of the improvement to recoup himself for his outlay. In the United Provinces exemption is guaranteed until the expiry of the settlement next succeeding that during the currency of which the improvement was carried out. The term of exemption may therefore vary from 30 to 60 years. In the Central Provinces there is a similar rule, but as the settlement periods for many districts do not exceed 10 or 12 years, the periods of exemption will not exceed from 10 to 24 years. In the Punjab exemption from enhancement is guaranteed for a period of 20 years from the date of construction of the well, without reference to the dates of settlement. The question has been seriously raised whether, at any rate in the case of improvements for purposes of irrigation, and more particularly in the case of wells, the exemption should

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not be made perpetual throughout India. We regard it as outside our province to discuss the question whether the cultivator has any right to perpetual exemption, or whether the bestowal of it where it has been granted was necessary or wise. But we cannot pass over the question whether the grant of perpetual exemption is advisable as a stimulus to the future execution of private works of irrigation, and especially of wells; or whether the temporary exemptions provide sufficient encouragement where they are allowed.

179. We have examined the figures of progress in well-construction in the different provinces during the last decade, and summarize them in the following table :—

Province.	Number of permanent wells at		Increase.	
	Commencement of decade.	End of decade.	Number.	Per cent.
Madras	432,852	626,280	193,428	45
Bombay	188,812*	254,363*	65,551	35
Punjab	219,940	274,851	54,911	25
United Provinces . . .	447,199	499,404	52,205	12

* Includes probably some temporary wells.

Now it is remarkable that the increase in permanent wells is by far the greatest in the Presidencies of Madras and Bombay where exemption is perpetual; and it is strongly claimed by all witnesses whom we have examined in Madras that the great increase which has taken place there is mainly due to perpetuity of exemption. In Bombay, however, no such claim was made. On the contrary, although in that Presidency the exemption is given not merely by executive order as in Madras, but by express provision of law, there seems to be a remarkable ignorance of its existence, or exact comprehension of its meaning. We are inclined to think that in this case it can have had little to do with the increase in the number of wells, which is sufficiently accounted for by the stimulus afforded by a succession of severe famines and droughts, the long periods of settlement, and, in the Deccan, the light assessment on well lands. In Madras, however, the case is undoubtedly different. The effect and existence of the exemption are very well understood, having been emphasized at the settlement of thirty years ago, by the actual reduction of assessments from wet to dry rates on well lands. Also in the decade under examination, in Madras such famines as have occurred have been far less serious than those which affected Bombay, the United Provinces, and parts of the Punjab; and the stimulus given by drought, although no doubt considerable, must have been much less than elsewhere. *Takavi* has been distributed with great liberality in Madras. But of the 193,000 additional wells made in the decade, only 18,000 were made with the aid of *takavi*. This, therefore, does not account for the extraordinary increase. Part of it is attributable to improved enumeration. But this is a cause which probably operates in all provinces. It is of course impossible to be certain that a long temporary exemption would not have had equally beneficial effects. But, on the whole, we should find it difficult to escape from the conclusion that the perpetual exemption, thoroughly brought home to the people, has been a potent stimulus to the construction of wells. Whether the same concession is equally required elsewhere, is another question which requires to be answered according to the circumstances of the province or tract concerned. There are some places and circumstances in which, as is clear from the evidence, it would be exceedingly difficult to make the benefit of the exemption appreciated. Thus, in the Central Provinces, where the tenure is generally *zamindari* and the holdings are considerable, the effect of exemptions given in respect of particular plots has been so completely obscured by the enhancements which have accrued on entire holdings, that the people can hardly be induced

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to believe in the reality of the exemptions, even when evidenced by the *sanads* which they hold, and the assurance of officers in whom they have confidence.

180. Again, in most of the Punjab and in large portions of the United Provinces, the abundant water in the subsoil has always been regarded as an advantage for which the State and the landowner are justly entitled to a return. In Gujerat, where the valuation of land for assessment purposes is increased for proximity of subsoil water, this advantage is charged for whether a well is made or not. In the Punjab the subsoil water is charged for only when it is used, and after the user has been recouped for the capital expense to which he has been put in obtaining it for use. This latter practice, like the charge of a royalty on minerals, is unobjectionable in principle, and in practical working has much to recommend it. The financial effect of it is such that, as shown by the Hon'ble Mr. Wilson and Colonel Grey, if the State were to make advances for wells entirely without interest, they would pay as an investment owing to the increased revenue which the well-lands would bring in. As a mere matter of business therefore, in provinces where exemptions are only temporary, the State will be justified in advancing largely for wells, just as it would in spending money on a productive canal. Where exemptions are perpetual, the liberality in the matter of *takavi* and grants-in-aid must be measured solely by the needs of the tract, and the saving which will accrue to the State in famine expenditure and loss of revenue consequent on famine; by the considerations in short which justify the construction of protective as distinguished from productive irrigation works. Our general conclusion is that in Madras the permanent exemption of improvements from taxation has justified itself as an effective encouragement to the construction of wells; and that its trial for that purpose in other provinces where exemption is at present only temporary, would be justified in tracts exposed to famine in which special encouragements are required. We also think that in Bombay special pains should be taken to give the widest publicity to the provisions of the law, and to the emphatic promises and declarations of Government, with the view of disabusing the people and subordinate officials of any misapprehensions which they may entertain on the subject. We would also suggest a consideration of the question, whether the rules applicable to the Central Provinces and to the Punjab might not be so far modified as to secure to improving landowners in those provinces a period of exemption from enhancement of revenue on account of their improvements which would not be less than that which is now given in the United Provinces.

181. *Exemption of tenants' improvements.*—It seems doubtful whether, in most of the provinces, the permanent tenants have received such full protection against enhancement of rent, in respect of the increased value imparted to their land or its produce owing to improvements made by them, as the landowners obtain from Government against enhancement of the land-revenue assessment on lands benefited by improvements which they have executed. In Madras there is no tenancy law over the large areas of the permanently-settled *zamindaris*, in which the revenue of the landowner is of course exempt from assessment on any pretext whatsoever. In Bengal and the United Provinces the law generally contains provisions exempting the tenant, expressly or by implication, from liability to enhancement in respect of increased value due to his improvements. But in some cases the beneficial effect of this law is apparently nullified, or in danger of being nullified, owing to other provisions which enable the landowner to claim at intervals enhancement up to the rate prevailing on land enjoying similar advantages, or, in other words so far as pertains to our subject, similar facilities for irrigation. In the Punjab the cash paying tenant is protected by the remarkable provision that no enhancement shall be taken until he has been compensated for his improvement. The tenant, however, who pays rent in kind, is not protected. If we correctly understand the law in the Central Provinces, the tenant there is not liable to enhancement during the currency of a settlement except on the ground of improvement executed by the landowner, or of an increase in the area of his (the tenant's) holding. But at a revision of settlement he is apparently liable, as in the United Provinces and Bengal, to enhancement up to the prevailing rate on land enjoying similar facilities for irrigation. In Bombay and the *rayatwari* districts of Madras, there

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are no occupancy tenants, and their case, therefore, hardly requires consideration. But as regards the other provinces mentioned, we think that the Tenancy Law should be examined and amended so far as may be necessary to secure for the tenant a liberal period of exemption from enhancement of rent in respect of increased value due to any improvements which he may execute. The period need not, perhaps, be as long as that which the landowner is allowed by Government in respect of the land-revenue assessments. But it should be amply sufficient to recoup the tenant for any reasonable outlay incurred by him on his improvement.

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CHAPTER VI.—LOANS FOR IMPROVEMENTS.

182. *The takavi system.*—Of all the methods by which Government is able to stimulate and assist private irrigational improvements, the most convenient and obvious is the system of State advances to the cultivating and land-owning classes, known as *takavi*. We propose, therefore, to consider briefly what use has been made of this system, and how far such use is capable of extension and the system capable of improvement. This system has existed in India from time immemorial, and is now regulated by special laws, namely, the Land Improvement Loans Act (XIX of 1883) and the Agriculturists' Loans Act (XII of 1884) for the whole of India, and by rules under these Acts framed for each province by the Local Governments and sanctioned by the Government of India. Under the former Act money is advanced for specific purposes of land improvement, and under the latter for seed, cattle, and other miscellaneous agricultural purposes. But the objects of the two Acts are closely connected, for it will often be the case that in order to make efficient use of his improvement the cultivator will find it necessary to provide himself with cattle and manure, well-gearing and the like, if not with seed.

183. The following table shows the total amounts advanced in the various provinces under the two Acts during the ten years ending 1900-01:—

Amounts of loans advanced during the ten years ending 1900-01 (in thousands of rupees).

Province.	Agriculturists' Loans Act.			Land Improvement Loans Act.						Total.
				In ordinary years.			In years of drought.			
	In ordinary years.	In years of drought.	Total.	Wells and irrigation.	Other purposes.	Total.	Wells and irrigation.	Other purposes.	Total.	
North-West Frontier.	2,84	...	2,84	98	16	1,14	...	...	...	1,14
Punjab . . .	28,93	12,23	41,16	10,12	9,09	19,21	1,91	5,40	7,31	26,52
United Provinces .	31,89	22,83	54,72	9,52	...	9,52	16,97	...	16,97	26,49
Bombay . . .	14,03	126,24	140,27	18,28	17,58	35,86	56,39	23,25	79,64	115,50
Sind . . .	6,34	6,81	13,15	6,28	18	6,46	3,76	...	3,76	10,22
Bengal . . .	5,61	10,43	16,04	3,33	27	3,60	3,32	3,51	6,83	10,43
Madras . . .	8,12	8,31	16,43	45,63	10,90	56,53	1,33	1,69	3,02	59,55
Central Provinces .	18,00	37,00	55,00	1,82	...	1,82	13,83	...	13,83	15,65
Ajmer-Merwara .	2,76	2,59	5,35	3,69	3	3,72	1,39	6	1,45	5,17
Berar . . .	48	2,41	2,89	2,58	2,27	4,85	92	71	1,63	6,48
Total .	119,00	228,85	347,85	102,23	40,48	142,71	99,82	34,62	134,44	277,15

184. It will be seen that in this period 625 lakhs of rupees have been advanced by Government, 348 lakhs as agricultural loans, and 277 lakhs for the specific purpose of land improvement. Of this latter sum 202 lakhs are returned as having been advanced for wells and irrigation, including in these categories tanks, wells, temporary dams, irrigation channels, and the like. The remaining 75 lakhs are returned as having been advanced for other purposes. But out of this sum a considerable amount has actually been expended on irrigation. Thus 10 lakhs at least have been given in the Punjab for village water-courses in the Chenab and Jhelum colonies, and at least 30 lakhs have been allotted in Bombay for field embankments and similar works. Out of the total advanced under the Land Improvement Loans Act, therefore, at least 242 lakhs or about six-sevenths may be taken as having been advanced for irrigation purposes. Out of the amounts advanced under the Agriculturists'

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Loans Act substantial sums have been given in Sind for canal clearance, and in all provinces for such objects as the provision of lifting gear for wells and other purposes closely connected with irrigation. Of the large sums given out during the famines for cattle and seed, a very considerable proportion must have been required for the working of wells or the cultivation of lands under both wells and other sources of irrigation, which lands, but for the aid afforded, could not have been cultivated. It will be observed that considerably more than half of the total advances were given in years of severe drought—generally speaking the famine years 1896-97 and 1899-1901 when large concessions were made, on account of the impoverished condition of the cultivators, to stimulate the construction of wells in the drought-stricken areas, and to provide employment on other works of agricultural improvement, mostly of direct or indirect irrigational value, for many of the labouring classes who would otherwise have come on to the State relief works. The amount of the loans in the famine years cannot therefore be taken as a criterion of the use which has been or can be made of the system in ordinary years. They indicate, however, what large sums can be disbursed when a keen demand has been excited by urgent necessity, and when the energies of a large staff of officers are concentrated upon meeting that demand.

185. It will be instructive to analyze further the figures of advances for land improvement in ordinary years. The first noteworthy point is that out of the 142 lakhs advanced, Madras has given 56½ and Bombay nearly 36, or between them, 92½ lakhs. The Punjab comes next with little more than 19 lakhs, while Bengal, the United Provinces, and Central Provinces, give only 15 lakhs between them. Berar and Ajmer-Merwara gave each twice as much as the Central Provinces. On the other hand, out of the 119 lakhs advanced as agricultural loans, no less than 78 were given in the Punjab, United Provinces, and Central Provinces.

186. Now the diversity of conditions in the various provinces is such that it would of course be unreasonable to expect an equally full use of the *takavi* system in every one of them. But we are strongly of opinion that this diversity does not sufficiently account for the much greater freedom with which the advances are given for land improvement in the two Southern Presidencies, and for other agricultural purposes in the Punjab, United Provinces, and Central Provinces, than in other parts of India. We are far indeed from saying that even in Bombay and Madras the amounts advanced for land improvement have been as large as they might have been if the Governments and their officials on the one hand, and the people on the other, had been fully alive to their opportunities. It is worth noting that in Bombay during the normal years 1893-94, 1894-95, and 1895-96, out of 18 lakhs advanced, 12 were given in the three districts of Belgaum, Dharwar, and Bijapur, of the Southern Division, where vigorous measures had been first started on the initiative of an individual officer who for a series of years administered the collectorates of Dharwar and Belgaum. Similarly in the Madras Presidency out of 30 lakhs advanced in the years 1891-92 and 1892-93, 15 were taken up in the single district of Coimbatore. The years were deficient in rainfall, but Coimbatore was by no means the most severely affected district, and the large amount of *takavi* taken was largely due to the exertions of the Collector of the time. It is not perhaps too much to say that the history of the fluctuations in the amounts of *takavi* taken up in any province, is the history of the interest taken in the matter by individual officers who were quick to apprehend the kind of improvements which the agriculture of their districts required, and the value of *takavi* advances as a stimulus to the execution of such improvements as were most suitable to the locality and its needs. Thus the advances in the Bombay districts mentioned were spent chiefly upon the levelling, terracing, and embanking of fields, while in the Coimbatore district of Madras they were spent chiefly on wells. And there can be little doubt that, if all Collectors in Madras and Bombay had taken the same interest in their *takavi* work as the heads of the districts mentioned, still larger sums would have been advanced throughout the two Presidencies than have yet been given in ordinary years. But if this is the case in Southern India far more is it so in the Northern

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Provinces where so little *takavi* has been granted up to the present for land improvement, except in famine years. In this view we are supported by the local members who have been associated with our Commission. Thus Mr. Wilson thinks the Punjab Government might distribute ten lakhs per annum against the one lakh which it has hitherto given for wells. Mr. Craddock would have an expenditure of four lakhs in the Central Provinces as against a fourth of a lakh; and Mr. Allen, of Bengal, without stating any specific sum, considers that the advances might be very largely increased in that province.

187. *Advances by the Opium Department.*—A strong proof, if proof be required, that much more can be done in ordinary times by means of State advances than many are inclined to suppose, is to be found in the operations of the Opium Department, which every year advances very large sums to cultivators of poppy, on condition that certain areas are put under that crop, and, in addition, a certain amount for wells, which, however, are used for other crops as well as for poppy. We do not suggest that it would be possible for Collectors to advance on the same scale. But the work of the Opium Department shows that there is no insuperable difficulty, or reluctance on the part of the cultivator, to prevent him from taking State advances from Government for agricultural purposes, when the advantages to be gained have been properly impressed upon him.

188. *Stimulating means required.*—Although, then, there are defects in the *takavi* system to which we shall advert below, and improvements to be made, yet the first and perhaps the principal measure required is to quicken the interest of all classes of revenue officers in *takavi* work, to place liberal allotments at their disposal, and to inquire strictly into the causes of failure to spend up to them.

189. *Rate of interest.*—We have inquired carefully into the extent to which the free use of *takavi* is hindered by defects in the law, rules, and administration. In the first place we have no hesitation in saying that the rate of interest charged is not in itself excessive. That rate is $6\frac{1}{4}$ per cent. (one anna in the rupee) for all classes of improvements, except in Madras and Bombay where the charge now is only 5 per cent. These rates are so far below the market rate of interest that the people regard them as extremely liberal. Some witnesses have recommended lower rates with a view of popularizing the system; but no one has been found to assert that the existing rates were too high. The Opium Department, however, make all their advances, including those for wells, without interest. It would also appear, from calculations made by Mr. Wilson and Colonel Grey, that the Punjab Government, with interest at $6\frac{1}{4}$ per cent., gains substantially by the present system. The Imperial Government which advances money for these loans to the Provincial Governments at 4 per cent. while itself able to borrow at little over $3\frac{1}{2}$, also presumably gains appreciably. We think that these loans ought not to be made a source of profit to the State, and that the interest on them should be reduced to a point sufficient merely to cover the risks taken. At present the amounts found to be irrecoverable are inappreciable; and the charge for risk might, therefore, be correspondingly small while the security remains as good as at present. We have made recommendations which may slightly increase the risk, but, even if they are accepted, we would suggest that the rate of interest may with advantage be reduced to 5 per cent. in all provinces. We think that such a reduction will be likely to strike the popular imagination as an act of great liberality, and may increase the attractiveness of *takavi* loans in far greater proportion than might be anticipated from the small diminution which would result in the actual payments by each individual cultivator.

190. The remarks in the preceding paragraph refer generally to *takavi* advances in all parts of the country. We have, however, also, carefully considered whether in precarious tracts where it is desired to give a special stimulus to irrigation, it would be desirable to reduce the general rate of interest or grant loans free of interest. On the whole we are of opinion that it would be preferable to make free grants-in-aid, as proposed below, charging full interest on the remaining part of the sum required, which will be treated as an ordinary *takavi* advance. This plan has numerous advantages. The financial arrangements will be sounder and simpler. The free grants will be chargeable to some

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final head of expenditure, such as 'minor works, agricultural.' It will be easy also to work a system of free grants with considerable elasticity. Thus the grants might vary from *nil*, by tenths to, say, five-tenths; or by sixteenths, to eight annas in the rupee, of the total sum required.

191. *Rigidity of collection.*—There is no cause of the alleged unpopularity of the *takavi* system which has been more frequently testified to than the rigidity of the system of collection. It is pointed out that the money-lender gives time readily to the client with tolerable credit. Government rarely or never gives time. There can be hardly any doubt that this does constitute an objection in the mind of the cultivator to become a debtor to Government, provided that he can get the money on sufficiently easy terms elsewhere. It is not that he has merely to pay the interest. This would probably be no greater burden to him than an addition to his land revenue assessment, which he pays with remarkable punctuality. But he has also to pay an instalment of principal which, if his crops are poor, may be a considerable burden. The Collector or head of the district has authority, under the rules in all provinces, to suspend payment on the occurrence of failure of crops or other exceptional calamity, subject, however, to a report to higher authority. But this power of suspension is not very frequently exercised, except in years of very general failure of crops; and when it is, the result is merely to postpone payment of the instalment for a single season, with the result that in the ensuing year the cultivator has to pay double the usual amount. The increased payment must often be raised with difficulty, and it is probable that under the circumstances cultivators would seldom care to apply for suspension of *takavi* payments. We are of opinion that suspension should be given without hesitation whenever, from causes beyond the control of the borrower, his crops fail to such an extent as to render the payment of the year's instalment unduly burdensome to him; that whenever suspensions of revenue are granted they should carry with them automatically suspensions of the *takavi* instalment which may be due the same year; that the officer who has authority to grant the loan should also have authority to grant the suspensions; and that the suspended instalment should not be made payable in the ensuing year with the instalment of that year, but that the effect of suspension should be to postpone by one year the payment of all remaining instalments due on the loan. It seems also unnecessary for the head of the district to report each case of suspension, as it occurs, to superior authority. Greater leniency in the matter of recovery cannot well be exercised by Government, which in these matters is unable to place itself in the same position as a private creditor.

192. *Period of repayment.*—There is, however, a measure which would undoubtedly go far to mitigate the hardship of rigid recovery, and that is the lengthening of the periods of repayment. In several places these periods have been criticized as too short. But opinion is not unanimous on the point, many witnesses considering that the people are perfectly satisfied with the periods allowed. It is remarkable what a reluctance there appears to be to work up to the full period of thirty-five years allowed by law. Except in Madras, where the period for wells is fixed at thirty years, in no province may the Collector fix a period longer than twenty years, while in Bengal his discretion is limited to ten, and in the Central Provinces and United Provinces to fifteen years. In the Punjab the fixing of a period longer than twenty years actually requires the sanction of the Government of India, which it is observed will only be granted under very special circumstances, and the injunction is given that advances must be repaid in as short a period as is consistent with the object for which they are made. This order indicates the spirit in which the law and rules have been worked, and the effect has been that loans are seldom granted, even for the full period for which the Collector has discretion. Short periods of repayment are considered to facilitate recovery, and are alleged to be in the true financial interest of the borrower. But neither of these considerations is mentioned or alluded to in the law, which prescribes that, in considering the periods for loans, regard should be had (*a*) to the durability of the works, and (*b*) to the expediency of their cost being paid by the generation of persons immediately benefiting by them. [Section 6 (3), Act XIX of 1883.] In our opinion the borrower may be left to judge what his own financial interests and those of his successors are in this

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matter, and it seems to us hardly necessary for the Legislature to direct that attention should be given to consideration (*b*). Up to the present, the periods sanctioned have generally been so short that it can rarely have been brought into account at all; and if, in the future, longer periods are allowed, it will be many years before the enthusiasm of the cultivating and land-owning classes for agricultural improvement is raised to such a pitch as to pass the bounds of prudence, and so endanger the prosperity of succeeding generations. On the contrary, we apprehend that, by the encouragement of such investment, posterity are likely on the whole to reap substantial benefits. There is, also, no apparent reason why, when desiring a loan for an agricultural improvement, the borrower should be fettered by considerations which are never allowed to stand in the way of the far more extensive borrowings which are made for purposes of unremunerative and extravagant expenditure. Generally speaking, then, the sole consideration in determining the period of repayment should be the durability, or what we may term the 'life' of the work; the full period so determined should be offered to the borrower; and no pressure whatever should be placed upon him with the object of inducing him to choose a shorter period.

193. Now there are some works, *e.g.*, soundly constructed wells in various parts of the country such as the Bombay Deccan, which, if properly maintained, will last practically for ever. In such cases there would be no objection, according to the principles stated above, to the acceptance of a perpetual charge equivalent to the interest on the capital advanced, instead of an instalment sufficient to extinguish the debt within a term of years. This proposal deserves examination. In some Native States money is frequently advanced for well-construction in return for an additional assessment upon the land benefited. But in the Northern Provinces of British India, where the period of the exemption of improvements from taxation is not perpetual, this practice could not be worked at all; and in Southern India it might be looked on, though erroneously, as infringing the principle of such exemption. Many good authorities doubt whether the rayat would like the perpetual charge. This is a matter of opinion which cannot be settled until the feeling of the people has been tested. But we are ourselves somewhat reluctant to suggest permanent indebtedness as a possibility. There is an undoubted stimulus to thrift, and advantage to the borrower, in arrangements enabling him to extinguish his debt within a reasonable period; and if the period of repayment be made long enough, the excess of the annual payments over the perpetual charge will not be large enough to deter people from borrowing. Thus, supposing the period which might be allowed for wells in the Bombay Deccan, where if properly made and maintained they are virtually indestructible, to be fifty years, then at 5 per cent. interest a payment of Rs. 5-8 would extinguish within that period a debt of Rs. 100, whereas the perpetual charge would be Rs. 5, or only 8 annas less per annum. No reasonable man would prefer the perpetual charge for the sake of saving the 8 annas. On the other hand, as the figures given below show, the perpetual charge would be a far easier annual burden than the instalment required to discharge the short-term loans now given, in which the period extends to but seven or ten years, or even a loan for as long as twenty or thirty years.

Sum required to discharge a loan of Rs. 100 at 5 per cent.

	Rs.
in 7 years	17·3
„ 10 „	13·0
„ 20 „	8·0
„ 30 „	6·5
„ 50 „	5·5
perpetuity	5·0

194. This policy of offering long periods of repayment should be followed in all parts of India. For there is no part in which there is not great room for the extension of agricultural improvement, or in which the State ought not to encourage such extension to the utmost of its power. But in tracts secure from

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famine or severe scarcity, the State will not be justified in running extraordinary risks, and in such cases a strict estimate should be made of the life and durability of the improvement. Following these principles, then, we recommend, either that no maximum period should be prescribed by the law, or that the maximum for the whole of India should be far longer than the existing maximum of thirty-five years. In view of the considerations stated below, fifty years would seem to be a suitable term. Within the provinces, Local Governments might be empowered to prescribe in the rules maximum periods for different tracts and districts, and for different classes of works, having regard to the durability of the work for which the loan is granted. As the rules require the sanction of the Governor General in Council, it will be easy for the Government of India to check any tendency, if it arises, to allow excessively long, or unduly short, maximum periods. The officer empowered to grant loans should in every case have full power to fix the period within the maximum, if any, without prior reference to superior authority.

195. *Permanent charge for interest.*—There is another alternative which has much to recommend it. Working as before on the basis of a 5 per cent. rate of interest, the borrower, if he would build a thoroughly durable well, might be charged Rs. 5-8 per cent., to be paid so long as the well endures, without any demand for repayment of capital, although he might repay at any moment any portion he wished, thereby reducing the interest proportionately. This would be identical with the former proposal if the well endured for fifty years and no longer. It would be to the interest of the borrower to make the work last as long as possible, but if it failed within 50 years there would be a loss to Government. On the other hand, if the work lasted more than 50 years, Government would gain, as it would receive something more than the normal rate of interest. We think therefore that an arrangement of this description should be offered as an alternative to a loan for a long but definite term, in all precarious tracts where special stimulus is required. If the rayat does not like the arrangement, it can be dropped.

196. We cannot say which of these proposals would be regarded with greater favour by the borrowers, but there would be no loss to Government under either; although, from the point of view of the cultivator, there would appear to be a relinquishment of all claim to the principal, notwithstanding a very moderate charge as interest, which in the case of the latter proposal would also be relinquished as soon as the failure of the well rendered the payment burdensome. These terms would very probably appear to be far more liberal and attractive to the rayat than to the actuary. And in dealing with the people of this country, what may be called sentimental considerations of this sort, are of great importance.

197. *Delays in distribution, and exaction of underlings.*—According to the evidence which we have taken, one of the greatest obstacles to the extension of *takavi* advances consists in the endless delay and trouble which seem inseparable from official procedure—the visits to head-quarters, the official inspection, and also the substantial portion of the advance which is apt to stick to the hands through which it passes. These evils seem to be universally recognized and admitted, and we have no desire to minimize them. But we have some doubt as to the extent to which they have effectively lessened the demand for *takavi*. The payments to underlings seem most unfortunately to be cheerfully acquiesced in by the people, and probably do not exceed the discounts and commissions which any client will have to surrender to his money-lender in the course of his haggling with him. The head-quarters of the district or subdivision are often not farther away than the shop of the money-lender with whom the rayat transacts business. We are unable to suggest any general remedies. But there seems to be no reason why journeys to head-quarters should not be shortened or saved, by giving powers generally to sub-divisional officers, and even to tehsildars as in Madras and Bombay, to grant advances within certain limits, instead of retaining the whole power in the hands of the Collector, as seems to be done in other provinces. It has also been stated again and again before us that if an officer of standing were to go into camp with money in his hand, receive

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applications, inspect sites, settle terms and make advances on the spot, many of the difficulties would be removed. This was the procedure perforce adopted in time of famine, when there was no other way of getting the large allotments promptly disbursed. Similar methods are pursued by the Opium Department in the distribution of their advances. We recommend that the experiment be tried in districts in which it may be determined to make large advances in future. There are few provinces in which it would not be possible to select tracts in which very considerable sums might be distributed in this way with the certainty of great benefit to the people and the Government.

198. *Inquiries regarding security.*—One of the chief reasons for delay in the disposal of applications for *takavi* has been found in some provinces to arise from the length and complication of inquiries into the sufficiency of the security offered. In most cases the security taken is the land to be benefited. Its value is easy to ascertain sufficiently well for practical purposes. The principal object of the inquiries is generally, therefore, the extent to which the land has been previously encumbered. Now it was probably the intention of the framers of section 7 (1) (*c*) of the Land Improvement Loans Act that the land benefited should be saleable for recovery of *takavi* arrears, just as it would be for recovery of arrears of land revenue, free of all encumbrances. But doubts have arisen as to the exact legal effect of this provision. These doubts should, in our opinion, be set at rest under competent legal advice, or if need be by one or two test cases ; and then, if necessary, the law should be amended so as to give effect, beyond any possible question, to what appears to have been the original intention of the Legislature. Once the land is made saleable free of all encumbrances, elaborate inquiries into their existence will be no longer necessary. The just rights of prior encumbrancers seem to be sufficiently guarded by section 5 of the Act, which provides that officers may, if they think it expedient, publish a notice calling for objections to the grant of the loan, and must consider objections submitted, and make written orders admitting or overruling them. This provision could, if thought necessary, be fortified by making public notice compulsory.

199. The other remedy against prolonged inquiry into the matter of encumbrances is to prescribe, if necessary by law, that wherever a record-of-rights has been prepared, objections submitted by prior encumbrancers will be recognized only if the encumbrance has been previously entered in the record. This will enable the inquiring officer, by mere inspection of the record, to ascertain all prior encumbrances of which he need take account. The existence of prior encumbrances, however, should not necessarily bar the grant of the loan. The value of the land as security to the encumbrancers will generally increase by the improvement. The encumbrancer may foreclose and get the benefit of it. But its value for protective purposes will remain, and the security of Government in the land for purposes of recovering the advance will not be impaired.

200. *Transfer of occupancy rights.*—There seems to be little doubt that in *zamindari* provinces the fact that the occupier of the soil is generally a tenant without rights of transfer in his holding, throws considerable difficulty in the way of advancing him money for improvements. For the best and most obvious security for the advance, namely, the land benefited, is not available unless the landowner can be induced to stand in, and this he can seldom be prevailed upon to do. In the Central Provinces an attempt has been made to overcome the difficulty by making tenants' holdings saleable for the recovery of Government loans. We think the advisability of making similar provision in other provinces should be considered ; although most officers seem opposed to such a measure, mainly from fear, first of its leading to the acquirement by the occupancy tenant, to his ultimate ruin, of full rights of transfer, and secondly of the extreme opposition of the landowners. But opposition might be conciliated by giving the landowners rights of pre-emption : and as regards the risk to the tenants from an undue extension of the right of transfer, it may be observed that where the landowners have considerable estates as in many parts of the United Provinces and Bengal, the greater number of wells and other small improvements are

Tenancy Act, sections 46 (3) and 70 (3).

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made by the tenants; and the importance of providing the tenantry with the best possible security for advances seems sufficient to justify the running of a risk, which, after all, can be avoided by firmness and foresight on the part of the administration. We understand also that, as a matter of fact, transfers are even now often effected by tenants in the form of sub-leases. It may therefore be that transferable rights for *takavi* purposes will not add much to existing evils, if evils there be. If the sub-leases be valid and legal security for private advances, *takavi* might also be advanced on the strength of some similar form of conveyance to a Government officer.

201. *Joint security.*—There is, however, a way of making advances to tenants, otherwise than on the security of their land, which deserves mention; namely, the taking of joint security from several tenants. In Northern India the areas irrigated by wells are often so large that several holders may be interested in the same well. Indeed it seems to be a general practice in parts of the United Provinces for all the neighbours to use a well which commands their lands, by whomsoever it be made, after the wants of the owner are satisfied. Notwithstanding the frequent difficulty of inducing people to co-operate, it seems not improbable that in order to secure this user as of right, instead of merely by permission as at present, there would be no insuperable difficulty in inducing neighbouring tenants to stand joint security for one another. It may be observed that the Opium Department generally advances for wells on this system.

202. *Advances on personal security.*—But even if this measure fails, we think that the experiment ought to be freely tried, of advancing to tenants of solidity and character, upon their individual personal security alone. Their crops and personal property will often suffice to cover any but a very large loan; and the general integrity of *takavi* borrowers, as amply evidenced by the insignificant amount of irrecoverable loans, is an asset which should by no means be overlooked.

203. *Simplification of accounts.*—We regard simplicity in accounts and procedure as of the greatest importance, with the object of saving as much trouble as possible to the subordinate revenue officials who have it in their power to discourage applications for *takavi*. From this point of view we think the separate account of principal and interest a mistake. With an instalment of fixed amount, and with penal or compound interest exacted in only very exceptional cases, nothing more than the simplest record of repayments will be necessary.

204. It has been suggested to us that, when land revenue is recovered by rates upon the area cultivated or matured in each harvest, a *takavi* advance might be recovered by a percentage surcharged on the amount of land revenue, so that the recovery would be automatically adapted to the means of repayment. The idea seems to us admirable. Under this system, however, annual payments will vary considerably from year to year. It will accordingly be difficult to settle how much of each such payment should be credited to principal and how much to interest, and, generally, to determine exactly how the account stands, and to enable the borrower to keep a satisfactory check on his repayments. To meet this objection, and to simplify calculations and accounts, we would make a composition with the borrower for a definite sum, which would be determined on terms to be fixed for each tract. We would say to him, for instance—"You have borrowed Rs. 300. If you repay it by fixed instalments in twenty years, you will have to pay Rs. 24 a year or Rs. 480 in all. We will take so many annas in the rupee on your land revenue till you have paid Rs. 480, not charging more if the twenty years are exceeded, or less if the money is recovered sooner." The result will be that over a series of good years, when the revenue payments and surcharges would be relatively high, the Government would be repaid sooner, and receive a better rate of interest on the money lent, while over a series of bad years the period of repayment would be longer and the interest lower. If the terms of composition are judiciously fixed, Government will in the end lose nothing on an average of transactions, and the individual borrower will benefit by the adaptation of the loan recoveries to his fluctuating resources.

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205. *Establishments.*—If *takavi* advances increase at all upon the scale which we should hope and wish to see, there is certain to be a need for increases of establishments, at any rate in particular tracts where there is large scope for the work. A great deal can be done by trifling increases of the subordinate establishments, such as were long ago made in the three Carnatic districts of the Bombay Presidency alluded to in paragraph 186. But it is not unlikely that in other places more may be needed than this; and special officers with suitable establishments may have to be provided, either to deal with *takavi* work or to replace permanent district officials appointed to deal with it. It is of the first importance that the officers dealing with applications should know the locality and the people. It has been suggested that the entrusting of the distribution of *takavi* to a special officer who would not be responsible for its collection might prove to be dangerous. We do not attach great weight to this apprehension. Subordinate officials are only too prone to the belief that their reputation depends above all things upon the promptness and completeness with which they collect Government dues of all kinds; and transfers are so frequent that under the existing system, where all the *takavi* is worked by the district officials, the distribution of the advances, and the collection of dues which are paid in instalments spread over several years, must frequently be done by different officers. In districts in which agricultural banks may be successfully established, it may be possible to utilize their agency in the distribution of *takavi*, or even to make advances to the banks on their own security for the purpose of agricultural improvements.

206. *Procedure in time of famine.*—Our observations have, so far, been confined to the administration of the *takavi* system in ordinary times. In times of famine large departures will of course have to be made from the ordinary rules. It is unnecessary here to say more than that we entirely approve the system followed in recent famines, from 1896-97 onwards, in accordance with which very large sums were advanced for private irrigational improvements, and extraordinary concessions were made. There can be no doubt that, in addition to the actual help derived from the advances, a valuable stimulus was given to the execution of improvements out of unaided or only partially aided private resources. The only point on which we have to offer advice is that the greatest care should be taken in famine times to have the advances given out early. The authorities should begin offering the advances some time before it has become certain that the impending scarcity will develop into famine. For each district a sum based upon experience of requirements in previous famines should be fixed beforehand; and authority to disburse up to that sum should be given to heads of districts by the Local Governments as soon as they are satisfied that the emergency has arisen which would justify such a measure. The grant of such authorization would be reported at once to the Supreme Government as a warning of the financial provision likely to be required. In this way the delays incurred, at an important crisis, in the preparation of detailed estimates requiring a number of reports from the local officials, would be avoided. But these estimates could of course be prepared subsequently at comparative leisure. Small and temporary irrigation works are those which are likely to be most useful on the occurrence of famine, and all permanent allotments should be at once diverted to these, so far as is possible within the district.

207. *Special concessions in famine tracts.*—We have discussed above the methods by which the *takavi* system may be utilized for the development of private irrigation works. But we are convinced that, if progress is to be made at the full rate attainable with benefit to the country, still greater concessions will have to be made in tracts exposed to famine. These concessions should generally take the simple form of free grants of money, which may be fixed at a maximum of one-half the total amount required, up to a limit of say Rs. 500. The localities in which these grants would be justifiable may be characterized broadly as those tracts which have suffered severely in any great famine, such as those of 1876-77, 1896-97, and 1899-1900, and have not since obtained, by irrigation or otherwise, protection sufficient to guarantee them against the recurrence of similar calamities. As we have already pointed out in paragraph 168, there may often be in such tracts better financial justification for the grant for wells than for a canal depending upon storage. We do not, however,

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contemplate the bestowal of free grants in every case even in such a tract, but only when the concession is justified by the poverty of the applicant, or where the margin of profit from irrigation is so close that the concession will make the difference between profit and loss to the irrigator. The proportion of the free grant to the total sum required should, we think, vary with the circumstances both of the tract and of the grantee; and as the development of irrigation in any tract progresses, it will be reasonable to reduce that proportion gradually to *nil*. We do not desire that taking of *takavi* should be a necessary condition of receiving a free grant. Such grants should be allowed to cultivators who are, although poor, thrifty enough to provide the remainder from their own resources.

208. Some witnesses have proposed that in precarious tracts a bounty should be given on every well. The plan has the merit of simplicity. But, provided that no inordinate difficulties are found in determining the resources of the grantee, it may be doubted whether the plan would be so successful in getting the maximum number of wells constructed as that which we recommend. Our proposal restricts grants to people of slender resources, and so encourages more people of this class to construct wells with the aid of funds which under the alternative scheme would go to people of ample means, some of whom would make wells without Government aid. Other concessions such as postponement of commencement of repayment until the work begins to be remunerative, partial remission of the sums advanced in case of failure of the work, exemption of improvements from enhancement, and so forth are discussed in the chapter on private improvements. For reasons assigned in paragraph 190, we deprecate advances of money free of interest or at abnormally low rates.

209. *Disbursement of loan, and inspection of work.*—In order to secure that loans and grants are expended upon the objects for which they are granted, it will be necessary to observe carefully the precautions which we believe are already enjoined in all provinces, namely, the inspection of the works and the disbursement of the money allotted in instalments, the second instalments not being granted until the local authority is satisfied that work to the value of the first has been executed. Where advances are large, it will be necessary to have a special agency for inspection; elsewhere probably the work can be done by the ordinary establishments, with such additional strength as may be required for the distribution of advances on the larger scale now contemplated. It is possible that the inspections may be turned by subordinates into an occasion for blackmailing. But we do not see how they can be dispensed with. The subordinates' inspections should be checked as far as possible by superior officers, who should regard this duty as one of the most important items of village inspection work. Care should be taken that the advance or grant will fully cover so much of the total outlay required to construct the work as the borrower is unable to provide from his own resources. Insufficient allotments merely lead to waste and tempt the borrower to misapply the money received.

210. *Forecast of outlay in each province.*—In order to give some rough idea of the sums which may have to be provided during the first few years until repayments of *takavi* begin to flow in, we hazard the following forecast of the amounts likely to be required annually in each province :—

Province.	Total.	Free grant.	Takavi.
	Lakhs.	Lakhs.	Lakhs.
Madras	20	5	15
Bombay	15	5	10
United Provinces	10	2	8
Punjab	10	1	9
Bengal	9	1	8
Central Provinces	6	2	4
Other Administrations	5	1	4
Total	75	17	58

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The amounts at present allotted to these provinces for *takavi* alone average 19½ lakhs in ordinary years. What we virtually recommend therefore is that Government should treble the existing *takavi* grants, and make an allotment of 17 lakhs for free grants-in-aid of works of private improvement, under some definite head of expenditure, say, 'minor works, agricultural.'

211. We have very little on which to base this forecast, except conjecture and the opinions of well qualified officers. The exact allotments will have to be settled with Local Governments and Administrations. But even this expenditure will effect very little. Thus, calculating the expenditure required to protect an acre of land by means of the various private works at Rs. 100 in Madras and Bombay, and Rs. 50 elsewhere, we find that 75 lakhs would give protection to about one hundred thousand acres per annum. In twenty years, therefore, the protected area would have been increased by two million acres. A considerable portion of this, however, would not be in the areas liable to severe famine. It will probably be sanguine if we calculate that one and-a-half million acres within these areas can be protected in twenty years by means of *takavi* and grants-in-aid. Excluding Burma, the total area of cultivation exposed to famine may be put roughly at one hundred and fifty million acres. Thus, by means of *takavi* and grants-in-aid alone, protection can be given to not more than 1 per cent. of that area. This proportion is so small that, if reliance had to be placed on Government aid only, it might seem hardly worth while to lend it. But the value of *takavi* advances and grants-in-aid is by no means limited to the actual amount of work effected by their means; they give, in addition, a real stimulus to unaided private effort. Having regard to the rate of progress attained in the various provinces in the past without any assistance, or with the aid of comparatively little stimulus of the kind, we shall not perhaps be over-sanguine if we hope that the area under irrigation from private works may be doubled in fifty years. But even if this result be obtained, then deducting one-fourth of the increase as occurring in the areas not exposed to famine, the increase of protection in the famine-exposed tracts will not exceed 13 per cent. of their area; and it becomes evident that, notwithstanding every possible extension of private works, considerable areas must remain without protection by their means.

212. *Financing of advances and grants-in-aid.*—The amounts of the grants to be provided for *takavi* advances, and for grants in aid of private irrigation works, will necessarily come under revision from time to time, say, at intervals of five years; but the revision should be made rather with reference to requirements, and to the maximum amounts that can be effectively expended under existing conditions of administration, than to budget exigencies. We cannot too strongly insist that the success of the policy which we advocate will depend on its being pursued systematically and continuously, at whatever rate of progress may give the best results, and without being liable to interruption in years of great financial stress. We consider that the additional expenditure proposed will not impose any permanent burden on the State, for there will be an adequate return in the greater protection afforded against famine; but we apprehend that considerations of ways and means may sometimes render it difficult to carry out this policy continuously. Assuming provisionally that for the next few years the rate of expenditure will be as proposed, there may be a difficulty in providing the grants required out of current revenues. The 17 lakhs to be provided for grants-in-aid will be practically a new item of expenditure, while the grants for *takavi* will exceed the normal under this head by 40 lakhs. There will not only be a great immediate increase in the demand under the latter head, but its duration will be greatly prolonged if the period of repayment of loans is extended as we have suggested; and we have also proposed a reduction in the rate of interest which will involve the surrender of some of the profits which the State has hitherto made on its *takavi* transactions. We have suggested a universal rate of interest at 5 per cent. as the basis of all loan transactions for agricultural improvements in the belief that this rate will be sufficient to cover all the risks of loss, but if this rate is likely to be too low it must be increased. We think that the State should not look for direct financial profit on these transactions; but we recognize at the same time that it must be a cardinal principle of *takavi* transactions

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that they are self-supporting and involve no loss to the State, and that the expansion of operations which are recommended depends on the rigorous observance of this principle. Subject to this condition, however, we think that the only limit to the *takavi* grants should be the amount which the people are willing to take, and the officers of Government are able to distribute, with due regard to security and other considerations ; and that, if the amounts required cannot be provided from general revenues, some arrangement should be made under which the money could be obtained from loan funds, as for expenditure which will be essentially productive, and which will all be eventually recouped. These conditions will not apply to expenditure incurred on private irrigation works, which cannot properly be met from loan funds ; but we suggest for consideration that expenditure of this kind should be recorded under a new head, as grants-in-aid for private agricultural works, and should be chargeable against the famine grant, or, in other words, should be met from that portion of the grant which would otherwise be shown as applied for the reduction or avoidance of debt. We think that any expenditure which will tend to increase the protective efficiency of private works is as legitimate a charge against the famine grant as expenditure on non-productive irrigation works, and may be justified on the same ground—that it will tend to reduce the amount of future charges for actual famine relief, and is a better insurance against the cost of famine than a corresponding reduction in the public debt.

213. In order then to secure that continuity of policy and action which we have recommended, we further suggest that Local Governments and Administrations should be invited to submit estimates of the full amounts which they can distribute over a series of years, not less than five ; and that they should be given regular annual allotments up to which they should be expected to work. Failure to do so should be explained, but should not be made the ground for diminution of the allotments during the remainder of the period, unless the local authorities convince the Supreme Government that experience already gained has demonstrated the impracticability of spending up to them. Similarly, heads of districts and divisions should get for a term of years regular allotments based upon carefully framed estimates of requirements. The fixing of allotments, however, should not exclude the grant of special additional allotments on good cause shown. Allotments to provinces, or parts of provinces, unaffected by famine have sometimes been curtailed in order to satisfy the demand in affected localities. Such curtailments should be avoided, if at all possible with due regard to financial exigencies. Any check to the steady development of private improvements by means of advances is likely to have serious and permanent effect on the zeal of Local Governments and officials, on which the success of the system so largely depends.

214. *Summary.*—In order to make our proposals clear, we summarize below those which relate especially to precarious or selected tracts. The remainder apply to all parts of India in which *takavi* may be advanced for purposes of irrigational improvement :—

(1) Special liberality in estimating periods of repayment (paragraphs 192-194).
(2) Special arrangement specified in paragraph 195.
(3) Advance of money on the spot (paragraph 197).
(4) Payment by surcharge on fluctuating revenue (paragraph 204).
(5) Special famine measures (paragraph 206).
(6) Grants-in-aid (paragraph 207).

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CHAPTER VII.—ARTESIAN WELLS.

215. *Introductory.*—In reviewing all possible sources of irrigation in India, artesian wells must not pass unmentioned, if it be only to indicate the extreme improbability of such wells affording any appreciable measure of protection against famine. This view of the case may surprise those who have seen the strong rush of water from the fountains of Paris, and have not given consideration to the actual volume discharged or to the volume required for the irrigation of a very small field. A flow of water that might meet the domestic and sanitary requirements of a large town would cover comparatively a very small area if applied to the irrigation of land. Thus in many parts of India a flow of ten cusecs would be sufficient for the water-supply of a city with half a million inhabitants. If the same volume were turned on to the land, it would suffice for the irrigation of only three thousand acres—an area which would support under two per cent. of the population of the city. Moreover, wells yielding supplies like those of Paris are only to be found where the geological conditions are peculiarly favourable for artesian action. There are but few if any tracts in India of which this can be said, and they appear to be confined to very limited areas.

216. *Artesian wells near Pondicherry and Quetta.*—The only successful cases which have been brought to our notice of wells of an essentially artesian nature, that is giving a surface flow, are those in the neighbourhoods of Pondicherry and Quetta. In the French territory at Pondicherry, at a distance of about 2 miles from the shore, 11 wells, regarding which we have been furnished with statistics, give an aggregate discharge of under $5\frac{1}{2}$ cusecs—a volume which would suffice for the irrigation of about 1,600 or 1,800 acres. In many of the valleys of the Quetta-Pishin district of Baluchistan, the conditions are eminently suitable to artesian action. There are at present 25 wells in or near the station of Quetta itself, which yield in the aggregate under 2 cusecs, and only two of them are used for field irrigation, the remainder being devoted to drinking or railway purposes and the irrigation of ornamental gardens. It is evident, therefore, that at present the area irrigated in India by flow from artesian sources is quite insignificant.

217. *Prospects of extending irrigation from artesian sources.*—Nor can it be said that there are prospects of any considerable extension of irrigation being possible from these sources. The question is very fully discussed in a paper on "Recent Artesian Experiments in India" by Mr. E. Vredenburg (Memoirs of the Geological Survey of India, Volume XXXII, Part I). In that paper are given the results of the numerous deep borings which have been made in various parts of the country, and of the investigations which have been made by the Geological Survey of India. The conclusions to be drawn from Mr. Vredenburg's paper may be briefly stated as follows:—

(1) The prospects of finding artesian water along the southern border of the Gangetic basin are very remote. Nearer to the northern border the existence of artesian conditions has been definitely proved, but the strata bearing water under pressure sufficient to give surface flow, lie probably everywhere at a great depth. There are not sufficient data to show what flow may be expected; but it is, to say the least, extremely unlikely that, viewed from an irrigation standpoint, it would ever be sufficient to compensate for the great cost of boring.

(2) In the neighbourhood of the Gulf of Cambay the conditions appear to be favourable, but here, also, there seem to be small prospects of surface flow from borings of less than a thousand feet in depth.

(3) In the Satpura coal fields, and in the trap and sandstone formations of Central India and the Central Provinces, the geological

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conditions appear to be promising, but the number of borings made is insufficient to admit of definite conclusions being drawn.

(4) The trap area of the Deccan districts and the extensive area occupied by slates and metamorphic rocks and by schist and gneisses may be left out of consideration in the problem of artesian water-supply.

(5) Even where the rainfall is considerable, for an artesian reservoir to hold any large volume in store, there must be a combination of favourable circumstances such as a large intake area and a porous and thick stratum of fairly regular structure ; and although the amount of artesian water in India has scarcely received a fair test, yet it may confidently be affirmed that nowhere in the country do these exceptional conditions occur.

218. The general conditions, therefore, certainly do not point to India's being specially favoured in the matter of artesian supplies. But if the volume of water that can be obtained from these sources is not very much greater than that usually found in other countries, the whole area that it may be possible to irrigate by artesian water will have no appreciable effect in the prevention of famine. Even in America, where the conditions are often eminently favourable for artesian action, and have been very fully investigated, Major Powell, the late Director of the United States Geological Survey, reported in 1890 that, judging from the results obtained in that and other countries, the supplies obtained from artesian sources must always be limited and the area irrigated small.

219. In the Colony of Queensland, where considerable attention has been paid to the utilization of an unusually abundant artesian supply, there are 515 artesian wells yielding an aggregate discharge of 600 cusecs. The average depth of the borings is 1,188 feet, and the maximum 5,045 feet. The cost of the borings appears to average about thirty shillings or twenty rupees per foot of depth. But these deep and expensive borings were made chiefly for the purpose of affording a drinking supply to men and cattle; and an expenditure which would be justifiable in securing the water necessary for this purpose might be quite impracticable where the object was the irrigation of land. Thus many towns in Upper India have provided themselves with drinking water at a cost of four annas for every thousand gallons supplied. The average daily consumption being only about ten gallons per head of population, the cost for each person works out to under one rupee a year. But for each acre of ordinary cultivation at least 250,000 gallons would be required, and the cost of this at the same rate would be over Rs. 60 per acre, or about twice the whole value of an ordinary irrigated crop in Northern India.

220. From a Consular Report of 1902 we learn that from 1856 to 1890 in the South of the Department of Constantine in Algeria there had been bored 690 artesian wells having a mean depth of 142 feet, which yielded a total discharge of about 200 cusecs. In two other Departments 104 wells yielded 4·16 cusecs. Altogether these wells may perhaps provide 50,000 acres of cultivation—an area which becomes insignificant when compared with the many thousand square miles of the Algerian Sahara. It is in fact the great extent of the gathering ground required to give even a small artesian flow that renders these sources of supply inadequate for the irrigation of more than a comparatively insignificant area.

221. *Recommendations.*—Nevertheless there is, according to the geologists, a possibility of tapping artesian supplies in certain areas, and, judging from some recent results, the cost of a successful boring 1,000 or 1,200 feet deep would not be unreasonable if it yielded a supply of a quarter to half a cusec. For instance at the Ib river, in the Central Provinces, a boring in search of coal cost only Rs. 4,716 for a depth of 600 feet, and the contractors offered to go down to 850 feet for an extra Rs. 2,557. It would certainly be worth while in many parts of India to spend Rs. 10,000 for an artesian supply that

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would suffice for the irrigation of 100 acres, although, collectively, the total area that could be irrigated in this way might not lead to any substantial increase in the protection afforded against famine. On the whole, therefore, we think that, although the prospects of utilizing artesian wells for irrigation are not sufficiently promising to justify any considerable outlay, the possibilities should be more fully investigated, and that experimental boring should be made in any tract liable to famine in which the geologists may consider that the conditions are specially favourable for artesian action. It is possible that in such tracts a few bores might be made, each of which would protect a small area at a moderate cost, although it is certain that no considerable area can ever be protected by these means.

222. *Sub-artesian wells.*—We have hitherto been considering the case of those artesian wells in which a supply of water is delivered at or above the level of the ground surface. Even if wells of this kind can seldom be successfully made, there must be many cases in which water will rise in the bores above the level of the surrounding ground-water, although the hydrostatic pressure will be insufficient to force it to the surface. These are sometimes called sub-artesian wells. In paragraph 176 we have referred to the successful attempts which have been made in Gujerat and elsewhere to connect existing wells with water-supplies underlying the ground waters, and we have recommended that borings should be made for this purpose, and the results systematically recorded in a subsoil water-survey. We think that more may be done by improving the supplies to existing wells in this way, by means of borings of moderate depth, than by attempting to tap really artesian supplies by more expensive borings of much greater depth.

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CHAPTER VIII.—CLASSIFICATION AND FINANCING OF IRRIGATION WORKS.

SECTION I.—PRESENT CLASSIFICATION OF STATE IRRIGATION WORKS.

223. In previous chapters we have referred to, and in some cases briefly defined, various classes or sub-classes of State irrigation works—major and minor, productive and protective, Imperial and Provincial, navigation and agricultural; and in future chapters we shall have to make frequent use of these terms. We now propose to define them at some length, partly for the sake of explaining all references to them in other parts of this report, and partly as a necessary preliminary to the discussion of irrigation finance.

224. *Main classes of irrigation works.*—Irrigation works may be primarily divided into two great classes: those which have been constructed wholly or mainly from loan funds; and those of which the cost has been charged against general revenues, in the same way as the cost of a trunk road or civil building. The former are now called 'productive' and the latter 'minor' works. An intermediate class called 'protective' was, however, formed some time after the establishment of the Famine Fund. It had been decided that a portion of the amount credited annually to that fund should, when not required for purposes of famine relief, be devoted to the construction of famine protective railways and irrigation works, the balance being applied to the reduction or avoidance of debt. As the Famine Fund is formed out of current taxation, the cost of protective works is really met, like that of minor works, from general revenues; but there is this difference, that the cost of protective works is met from a grant which has been ear-marked for purposes of famine relief, protection, or insurance; and if these works were not constructed, the money would be applied to the reduction or avoidance of debt, or, in other words, be held in reserve for meeting the cost of future famines. An irrigation work is classed as 'productive,' and sanctioned against loan funds, when it has been shown to the satisfaction of the Secretary of State that it is likely to fulfil the conditions of a productive public work, that is, to yield a net revenue, ten years after completion, sufficient to cover interest charges on the sum at charge at that date. By the 'sum at charge' is meant the total direct and indirect capital cost, *plus* the excess, if any, of interest charges to date over net revenue. Small works and improvements of existing minor works are sanctioned against the ordinary grant for minor irrigation works, and are classed as such, whether they are likely to prove remunerative or not. Works which are too important to be classed as minor works, but which are not considered likely to fulfil the conditions of a productive work, are sanctioned as 'protective' works, if their construction is considered desirable as a protection against famine. Irrigation works of every class have a famine-protective value; and the term 'protective irrigation work' does not imply that the work is more protective than a productive or minor work, but merely that it has been sanctioned against the Famine Fund in consideration of its protective value, without any expectation that it will fulfil the condition of a directly remunerative or productive work.

225. There are, then, three main classes of irrigation works, *viz.*,—

(*a*) Productive works, capital outlay on which has been sanctioned against loan funds in the expectation that the works will prove directly remunerative.

(*b*) Protective works; works not considered likely to fulfil the conditions of a productive work, but which have been sanctioned against the Famine Fund on the ground of their protective value.

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(*c*) Minor works, outlay on which has been met from general revenues. This includes all works which have not been classed as productive or protective.

It may be remarked that the classification of a work as 'productive' or 'protective' depends on the estimate formed of its probable remunerativeness at the time of sanction, and does not necessarily denote that the work fulfils or does not fulfil the conditions of a productive work. Some works classed as 'productive' were sanctioned as such before the conditions of a productive work had been clearly defined, and others have failed to fulfil expectations. On the other hand, the Swat River Canal, which was classed as a protective work because it was at one time thought improbable that it would fulfil the conditions of a productive work, has proved highly remunerative and has more than fulfilled those conditions.

226. *Sub-classes of minor works.*—Similarly, the term 'minor works' does not necessarily connote works of small importance or of an unremunerative character. Many of the minor works are of considerable size and are very profitable. For some of them capital accounts are kept. A great many minor works are, however, old works constructed by former rulers of the country, which have been taken over and improved by Government; others are works which have been constructed by Government, and extended piecemeal from time to time as funds could be spared for the purpose from the ordinary irrigation grant; others are village works which have been constructed by private proprietors or communal effort, for the upkeep of which Government has undertaken certain responsibilities in consideration of the revenue which is dependent on their maintenance, or the control and management of which has been assumed by Government owing to disputes between the parties interested, or their inability to maintain the efficiency of the works. There are thus several types of minor works, which are sub-divided into three recognized sub-classes in the administrative accounts of irrigation works, *viz.*,—

(i) Minor works, for which capital and revenue accounts are kept.

(ii) Minor works, for which revenue accounts only are kept.

(iii) Minor works, for which neither capital nor revenue accounts are kept.

The principal works under (iii) are the village tanks in Madras which are referred to in Part II, paragraph 241.

227. The budget head 'Minor works' includes works other than irrigation and is divided into three classes as under:—

I. Minor works, Irrigation.
II. „ „ Navigation.
III. „ „ Agricultural.

Each of these may be divided into the three sub-classes shown above. Minor works, Navigation, comprise all purely navigation works, excepting the Hijli Canal which was sanctioned as a productive work. Minor works, Agricultural, include flood embankments and drainage works which are not connected with or ancillary to irrigation works.

228. *Distinction between major and minor works in the annual Finance Accounts of the Government of India.*—In the administrative accounts of irrigation works the transactions on each individual work or group of works are therefore recorded under 'productive works,' 'protective works,' and the various classes and sub-classes of 'minor works.' In the annual Finance Accounts of the Government of India, the revenue accounts of all works are exhibited under two main divisions, *viz.*, 'major irrigation works' and 'minor works.' The former term comprises all productive and protective works as defined above; the latter every class and sub-class of minor works. There are, however, important differences in the way in which the accounts of major and minor works are rendered in the annual Finance Accounts to which it is necessary to refer.

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229. The Finance Accounts show, for both major and minor works, all direct charges against the revenue accounts during the year, and omit, for both, the indirect charges that are debitable to the works, which consist mainly of charges to cover the leave and pension allowances of the establishment employed. The main difference in the form of accounts relates not to expenditure but to receipts. These are of two kinds: direct and indirect. The direct receipts comprise all recoveries of charges for irrigation which are made in the form of an occupier's or owner's rate which is leviable from crop to crop on the area actually irrigated, or for which leases have been taken; and also all miscellaneous receipts, as for navigation, use of water power, water-supply to towns, produce of plantations, etc. These together constitute the direct receipts. The indirect receipts represent enhancements of land revenue which are directly attributable to canal advantages, but which are distinguishable from and independent of the charge for canal irrigation. In Sind the greater part of the irrigation revenue on both major and minor works is indirect; but the water rates leviable in foreign States and in *jagir* lands are treated as direct revenue. In other provinces the irrigation revenue on major works is wholly or mainly direct, while on minor works it is generally indirect; but on many works of both classes the receipts are partly direct and partly indirect. The main difference between the Finance Accounts for major and minor works is that the former show for all provinces not only the direct receipts, but also the share of land revenue for which each work is entitled to a book credit; whereas the latter show the direct receipts only, which in the case of many minor works are but a small proportion of the revenue due to the works.

230. There is also another difference to be noted. The annual Finance Accounts show for each major work the amount to be debited as interest on the direct capital outlay, but for minor works interest accounts are not maintained. The sum of the debits to individual major works represents the share of interest charges on the public debt which is chargeable to revenue-producing irrigation works. These interest charges are struck on the total direct capital outlay, and not on the expenditure which has been actually met from loan funds; for the cost of protective works has not been met from loan funds at all, and part of the recorded outlay on some productive works has been actually met from general revenues. It is, however, immaterial whether the cost of a major work has been met from loan funds or from general revenue; in the former case, debt has been contracted; in the latter, the amounts spent on construction might have been devoted to the reduction or avoidance of debt, if the work had not been constructed.

231. It is not difficult to explain these differences between the Finance Accounts of major and minor works. The former have been deliberately undertaken more or less as commercial undertakings, or financial investments. Productive works have been sanctioned and constructed from loan funds in the expectation that they would be directly remunerative investments; and in the case of protective works a certain financial return has been looked for, although the works may have been sanctioned on other grounds. For all such works it is desirable to maintain regular interest accounts, and to record clearly all forms of revenue, whether direct or indirect, for which they are entitled to credit. With a few exceptions, however, minor works have not been undertaken in the same way. Government has been compelled, in the ordinary course of administration, to take over or to incur certain responsibilities in respect of a number of existing works, for the improvement or maintenance of which various sums have been allotted, from time to time, as part of the normal expenses of administration. The expenditure incurred on many of these works has been incurred in consideration of the revenue dependent on them, and has not been the *causa causans* of that revenue. In others it is difficult to distinguish between the areas of old and new irrigation, or to determine very accurately the increase of revenue due to the recorded expenditure. It is true that some of the larger and more recently constructed works, with capital accounts of their own, differ only from major works in that they were constructed out of the ordinary grant for minor irrigation works, and there would be no difficulty in accounting for them as for major works. But interest accounts cannot be

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maintained when there are no capital accounts, or when the revenue actually created by capital expenditure cannot be accurately determined. It is for these reasons that the finance accounts are not encumbered with interest or indirect revenue accounts for minor works, and do not therefore exhibit the true financial results of these works. The revenue dependent on each work or group of works and, if possible, the increase of revenue due to capital expenditure incurred are, however, shown in the annual Administrative Accounts of the Public Works Department.

232. *Imperial and Provincial works.*—Works of any class may be either Imperial or Provincial, according to the arrangements made at the time of framing the financial agreements which are entered into from time to time between the Imperial and Provincial Governments. We shall consider later on the general question of the provincialization of irrigation works; it will suffice at present to indicate in a few words the existing practice. Productive irrigation works have been provincialized in Bengal and the United Provinces; but in other parts of India they are Imperial. All protective irrigation works at present in operation are, without exception, Imperial. Minor works are Provincial in Bengal, the United Provinces, Madras, and Burma. In all other provinces they are Imperial, though there are a few small works in the Punjab, and one in Bombay, which are Provincial. The Punjab Provincial works have been constructed in recent years out of provincial revenues, and the Bombay work has been provincialized in the circumstances explained in Part II, 176.

233. *Powers of sanction.*—The Government of India have power to sanction estimates for ordinary public works up to a maximum limit of ten lakhs exclusive of charges for establishment. Local Governments and Administrations can sanction, up to the same limit, estimates for works which are chargeable to Provincial funds. In the case of Imperial works their powers of sanction are limited as below:—

	Rs.
Governments of Madras and Bombay	2,00,000
Other Local Governments	50,000
Local Administrations	20,000

These powers of sanction may be exercised in respect of minor works, but do not apply to new productive or protective works. As regards productive works, the capital cost of which is met from loan funds, the Secretary of State is at present the only authority that can sanction an estimate for a new work. Until recently all estimates for new protective works required the sanction of the Secretary of State, irrespective of the amount. This rule has been lately relaxed, and the Government of India can now sanction such estimates amounting to not more than ten lakhs, but the sanctions are reported to the Secretary of State.

234. After the closure of the construction estimate for a work, on its virtual completion, estimates for works of development, extension, or improvement, if not exceeding ten lakhs, may be sanctioned against the open capital account of the work without reference to the Secretary of State, under the following conditions:—

(i) If the work has fulfilled or is considered likely to fulfil the conditions of a productive work, estimates chargeable to the open capital account may be met from loan funds. The Government of India can sanction such estimates up to the limit, for any one work, of ten lakhs. The limit to the Local Government's powers of sanction in such cases is restricted to Rs. 25,000 or Rs. 10,000, according as the expenditure proposed is likely to be in itself remunerative or not. The former limit would apply to an estimate for a new distributary which would lead to an extension of irrigation; the latter to such a work as a new bridge or drainage work, required in connection with the project, but not likely to lead to an increase of revenue.

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(ii) In the case of works originally classed as productive, but which have not fulfilled and are unlikely to fulfil the conditions of a productive work, estimates chargeable to the open capital account may not be met from loan funds. All further capital expenditure on such works must be met from general revenues, that is, from the grants for minor irrigation works.

(iii) Expenditure chargeable to the open capital account of a protective or minor work may be sanctioned by the Government of India or the Local Government within the limits of their powers of sanction.

235. It will thus be seen that the power of sanctioning expenditure from loan funds on irrigation works has been very jealously guarded. A work must, in the first place, be classed as productive, and this cannot be done without the sanction of the Secretary of State. After the completion of the construction estimate, further expenditure cannot be incurred from loan funds, unless the work has actually fulfilled the conditions of a productive work, or gives fair promise of doing so within ten years of its completion. The orders of Government on this point are usually issued after the completion report for the work has been submitted and considered.

236. This practice is based on the principle that the public works debt should be productive ; and that no addition should be made to it for expenditure on revenue-producing works, unless there is a reasonable assurance that it will produce within a reasonable time an increase of net revenue sufficient to cover all charges for interest. The rigorous adoption of this policy in the past hardly requires justification. If large and costly projects had been recklessly constructed all over the country, in consideration only of the great indirect benefits that might be anticipated, and without reference to their value as financial investments, the burden of the irrigation debt would have served as the strongest argument against further extension. As it is, the few works classed as productive which do not fulfil the conditions of a productive work, were, with one or two exceptions, sanctioned before those conditions had been clearly laid down, and the works which have since been constructed from loan funds have proved highly remunerative. The total net revenue for the year 1900-01 from all the works classed as productive, including those which have proved unremunerative or are not yet fully developed, exceeded the interest charges for the year by over 115 lakhs and yielded an average return of 7·09 per cent. on the total direct and indirect capital outlay. It may be added that the works thus constructed have a far greater protective value than any that could have been constructed, at many times their cost, in those parts of the country which still require protection. Moreover, *pari passu* with the construction of these works, a number of protective but non-productive works have also been carried out, on a scale that has at any rate been sufficient to show the necessity for caution in the prosecution of such works.

Section II.—PROPOSALS FOR CLASSIFICATION AND FINANCING OF IRRIGATION WORKS.

237. *Sanctions against the Open Capital Accounts of Productive Works.*—However strongly the results referred to in the preceding paragraph may justify the financial policy which has been followed in the past, they may also be urged in favour of a relaxation of that policy in the future. We would, in the first place, recommend a reconsideration of the rule under which the cost of works sanctioned against the open capital account of a project which has not fulfilled the conditions of a productive work, must be met from general revenues and cannot be charged against loan funds. It may be said with reason that a large irrigation project can *never* be considered as completed; and that, if it is to be worked to its utmost capacity, continual additions to the capital account must be made, in the same way as they are made for railways or any other expanding commercial undertaking. In Part II of

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this report we show that, as a consequence of the excellent rule under which charges against the open capital account may be met from loan funds, this principle has been acted on with most satisfactory results in the case of all the great irrigation works which are really productive; but that in the case of the works which have not fulfilled the conditions of a productive work, there has been little or no progress since the completion reports on the construction estimates were submitted. The rule that the cost of subsequent extensions and improvements must be met from general revenues, has effectively prevented all attempts to render an unremunerative work less unremunerative or more efficient. This has been well illustrated by the history of the Kurnool-Cuddapah Canal; but the stagnant condition or low rate of improvement on all canals to which this rule applies indicates the desirability of relaxing it. The present rules do not even allow the cost of an improvement which would be in itself remunerative, and so tend to improve the financial return on the project, to be met from loan funds; though the strictest financial purist could hardly object to this being done. We would, however, go further and recommend that the cost of any work which may be sanctioned by competent authority against the open capital account of a work which is classed as productive, should be met from loan funds. It may be desirable to restrict the powers of sanction for such works, but we do not understand why the cost of *necessary* additions to the capital account of a work classed as productive should be met from general revenues merely because the work has not proved as remunerative as was anticipated when it was sanctioned; especially in view of the profits realized from the whole system of productive works of which it forms a part. This is, however, a minor matter, though the increase of the efficiency of several important works undoubtedly depends on it.

238. *Protective works.*—A question of still greater importance is whether it is any longer necessary to restrict the employment of loan funds to works which are expected to fulfil the conditions of a productive work; or, in other words, whether future progress in the construction of irrigation works which, whatever their protective value, are not likely to fulfil the conditions of a productive work, should be limited by the funds that may be available from general revenues, including the share of the famine grant that may be devoted to such works. There can be no doubt that, in the past, progress on irrigation works not classed as productive has often been restricted or prevented by budget exigencies; and as we propose a far more liberal expenditure on such works in future, we think it necessary to examine this question rather fully, as it is an essential part of any programme of irrigation works that progress in construction should be continuous, and should not be liable to suspension or interruption owing to budget exigencies. On general grounds, and subject always to one important condition, we see no reason why the cost of works for preventing or minimizing the intensity, extent, or cost of famines, may not be met from loan funds as legitimately as the cost of productive public works, or, to take a more apposite instance, as the cost of strategic railways. The condition to which we refer is that involved in the wise policy of the famine grant, which imposes on the current generation of tax-payers the obligation of providing annually a certain sum to be set aside for famine relief, protection, and insurance. We do not propose in any way to lessen that obligation; but merely to consider whether the present system of meeting the cost of new works is practically the most convenient that can be adopted. We recognize that, from a purely financial point of view, it is immaterial whether the cost of the works be met from the grant against which it will be a final charge, or whether it be met from loan funds, an equivalent amount being rendered available from the grant for the reduction or avoidance of debt. It is a question of accounts rather than of finance, as in the long run there would be no real increase to the debt in either case, unless the total expenditure on works should exceed the amount which under present rules may be contributed from the grant. We shall, in the first place, therefore consider whether the Famine Fund will be adequate for the regular financing of all new protective works that may be proposed.

239. The constitution of the Famine Relief and Insurance Scheme in its later form is clearly explained in paragraphs 531 to 538 of the Report of the

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Famine Commission of 1898. The leading features of the scheme, at the time that that report was written, may be thus summarized :—

(*i*) The annual amount of the grant had been fixed at 150 lakhs.

(*ii*) The first charge on the grant was the actual cost of famine relief. Money not required for this purpose might be devoted in part to the construction of protective railways and irrigation works, and the balance applied to the reduction or avoidance of debt.

(*iii*) In years in which the actual cost of famine relief was less than half the annual grant, the maximum sum to be devoted to protective railways and irrigation works was limited to half the grant, or 75 lakhs. During years of famine, when the actual cost of famine relief would be likely to absorb more than half the grant, the expenditure on protective railways and irrigation works was to be reduced to the lowest possible limits.

(*iv*) The payment of the excess over net revenue of the guaranteed interest charges on the capital accounts of the Indian Midland and Bengal-Nagpur Railways formed a first charge on the share of the grant allotted for protective railways and irrigation works. The Famine Commission stated that the annual amount of this charge appeared to average 40 lakhs. They suggested that, as most of the protective railways had been constructed, no part of the grant should, in future, be appropriated to the construction of new railways, and that the railway share of the grant should be restricted to the amount necessary to meet the interest charges referred to above. Taking these charges at 40 lakhs, it was shown that the maximum amount available for new protective works would be 35 lakhs, which would be subject to reduction in years of famine; and it was recommended that the greater part, if not the whole, of this amount should be devoted to protective irrigation works, provided always that a suitable programme were forthcoming.

240. The Secretary of State has accepted the recommendation that no part of the grant should be devoted to the construction of new railways; and under present rules the maximum amount that may be devoted to protective irrigation works may be taken at 75 lakhs, less the amount required to meet interest charges on the Indian Midland and Bengal-Nagpur Railways. We find that there has been a great diminution in the amount of these charges since the Report of the Famine Commission was written, that they will probably not average more than five lakhs for a few years, and that they are likely before long to disappear altogether. It thus appears that in ordinary years something like 70 lakhs may, as a maximum, be available for protective works; this may eventually be increased to 75 lakhs, but the amount may be subject to serious restriction in years of famine.

241. We have endeavoured in this report to indicate the field that exists in each province for the construction of irrigation works which will give the country all the protection against famine that irrigation is capable of affording, at a cost which would not be wholly indefensible and prohibitive. We are unable to state exactly what the total cost of the works will be, or what annual rate of expenditure may hereafter be attained on them. This will depend on the policy and circumstances of the future, which we can neither foresee nor control. But the need for protection against famine is great throughout the land, and we do not think it a sound policy to limit the progress in construction of works designed to afford the required protection, by the amounts which can be spared annually for the purpose from the general revenues of the country. Progress must at first be slow, but we are not without hopes that when the preliminary nvestigations which we have recommended have been made and the public works establishments have been brought up to the necessary strength for coping with the work that lies before them, a programme of valuable protective works will be forthcoming, on which there will be no difficulty in attaining an annual rate of expenditure far in excess of the amount that may under present rules be

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made available from the famine grant. At any rate we think that the expenditure should not be limited to the amount that can be provided annually from general revenues; and also that works should be so financed as to prevent the possibility of progress on those which have once been commenced being interrupted before they are completed, in order to prevent or reduce a deficit in the budget in years of famine or financial pressure. We consider moreover that, whether future expenditure on these works can or cannot be met from the famine grant, a change in the present system of classifying and financing irrigation works is desirable on other grounds. The present system appears to us to be unnecessarily complicated, and in some degree to obscure the position of the famine grant. For instance, if it is thought that a work will yield a return of $3\frac{3}{4}$ per cent. on the sum at charge ten years after its completion, it is sanctioned as a productive work and involves no charge on the famine grant. If, however, it is thought that it will be likely to yield a return of only 3 per cent., it is sanctioned as a protective work and the whole cost of the work is charged finally against the grant, the balance at the credit of which, or, in other words, the amount shown as applicable to the reduction and avoidance of debt, being reduced by the same amount. We may instance the case of the Swat River Canal, which, although classed as protective, is now actually paying 10·41 per cent. on its capital cost of over 41 lakhs. It is true that a large portion of this cost was not, as a matter of fact, met from the famine grant; but nevertheless a sum of Rs. $26\frac{1}{2}$ lakhs has been charged against the grant simply in consequence of a too cautious estimate of the financial prospects of the work when the revised construction estimate was sanctioned. As already stated, the distinction between productive and protective works is an artificial one, and the terms do not really denote that such works are actually remunerative or unremunerative, but merely indicate the estimate formed of their financial prospects at the time that they were sanctioned. The distinction is not maintained in the revenue accounts which are included in the Finance Accounts of the Government; nor is any similar distinction maintained in the case of railways. It will, moreover, often be difficult in practice to discriminate between the two classes in the new works that may hereafter be submitted for sanction, or to decide correctly the fund to which each should be chargeable.

242. *Capitalization of part of famine grant to meet capital outlay on protective works.*—It appears to us, therefore, that the distinction between productive and protective irrigation works should be done away with, and that all capital outlay on major works should in future be met from loan funds, all charges for interest which are not covered by net revenue being debited to the famine grant. This is the plan which has been followed in the case of the two famine railways, the capital cost of which has been met from other sources, while the payment of the excess of guaranteed interest over net revenue has been accepted as a charge against the famine grant. This plan appears to us more correct in principle than that which has hitherto been followed in the case of irrigation works, and much more convenient in practice. We feel some diffidence in recommending definitely a change of system which may be open to objections that have not occurred to us, but we desire to suggest the following proposals for the consideration of the Government of India:—

(*i*) That the present distinction between productive and protective works be done away with, both being included in the class of major works; and that all future capital outlay on major works be met from loan funds.

(*ii*) That the net interest charges, *i.e.*, the excess of full interest charges over net revenue, on every major work hereafter sanctioned should, until its interest account has been cleared, be shown against the famine grant.

(*iii*) Similarly, that the excess of net revenue over full interest charges on every major work hereafter sanctioned should be credited to the famine grant until its arrears of interest have been cleared.

(*iv*) That the balance of the famine grant, remaining after the cost of famine relief, the grants-in-aid of private agricultural works, and the interest charges on major irrigation works and the two famine

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railways, have been deducted, should be shown as applied to the reduction or avoidance of debt.

(*v*) That the Government of India be empowered to sanction all estimates for major works of which the amount for "works" does not exceed 10 lakhs of rupees; estimates above this amount only being forwarded to the Secretary of State for sanction. The powers of sanction of Local Governments and Administrations to be fixed hereafter.

243. With regard to (*i*) and (*iii*), the *modus operandi* would be simple. On the completion of the annual revenue accounts, all major works which may be hereafter sanctioned, and the arrears of interest on which have not been cleared, would be grouped into a separate list, and the excess of the total interest charges over total net-revenue would be debited to the famine grant.

244. Proposal (*iii*) has been framed to meet the objection that the interest charges during construction, and for the first few years after construction, of a work which is certain to fulfil the conditions of a productive public work, are not a fair charge against the famine grant. We consider it undesirable, however, to maintain a distinction for accounts purposes between productive and protective works; or a classification which does not really indicate whether a work is remunerative or otherwise, but depends solely on the estimate formed of its financial prospects at the time of sanction—an estimate which may be often falsified by the event. We propose, therefore, that the net interest charges on every new work hereafter sanctioned, whether likely to be productive or not, should be debited to the famine grant; but that, *per contra*, the excess of net revenue over interest charges, which will eventually occur in the case of the more remunerative works, should be credited to the grant until the interest account has been cleared. After this has happened, surplus revenue should be credited to general revenues and not to the famine grant. We have also proposed in (*ii*) that net interest charges, arising after the arrears of interest on a work have been cleared, should not be charged against the grant. When all arrears of interest for a particular work have once been cleared, the work must be regarded as remunerative; and, though a casual charge for interest may occur in an unfavourable year, it is certain to be cleared within a short time. We propose therefore that, as soon as the arrears of interest on any work have been cleared, it should be removed from the list of works, the net interest charges or surplus revenue on which are to be debited or credited to the famine grant.

245. It may be objected that this scheme does not provide for expenditure to be incurred under the open capital accounts of works already completed, as it is impossible to consider separately the interest charges due to this expenditure and those on the whole work. As regards existing works classed as productive, the only change in present practice involved in our proposals will be, that expenditure on the open capital works of a project that has not actually proved productive will be met in future from loan funds; but we have already expressed an opinion that such a change is very desirable. In the case of existing protective works, the capital cost of which has already been or is being met from the famine grant, we also consider it reasonable that further charges for open capital works should be met from loan funds, and should not be charged against the famine grant. The expenditure that may be thus incurred is not likely to be large,—for very large extensions would probably be sanctioned as separate works—and, whatever expenditure is incurred, it will often be in itself productive. It may also be pointed out that the grant receives no credit for any net revenue derived from these works, and it would on this account be unreasonable to debit it with interest on any future expenditure that may be incurred in connection with them.

246. *Advantages of the proposals.*—The principle of these proposals has been already accepted by Government in the case of the famine railways, and has been signally justified by the results which have ensued on its

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adoption. It must be difficult to overrate the protective value of the two fine railway systems which have been created at no greater cost to the tax-payer than the amount of the net interest charges which have been met from the famine grant; charges which have for many years been diminishing, and which are likely before long to disappear altogether. Similarly the adoption of our proposals will render it possible to give the country all the protection against famine which irrigation can afford, at a rate of progress which will be wholly independent of the famine grant, and which will be limited only by the strength of the establishment available for designing and executing the works. It will also protect the famine grant against final charges for expenditure on which a full financial return may be expected; and will lead to a simplification of irrigation finance and accounts which appears to us very desirable. It may be added that it will not have the effect of relieving the tax-payer of his obligations in respect of the famine grant. We do not propose any reduction in the amount to be annually reserved for purposes of famine relief, protection, and insurance; but merely a more convenient and effective distribution of the balance which is likely to be available for protection and insurance after providing for the cost of actual famine relief.

247. *Minor works.*—We have next to consider the financing of minor works. From what has been said in paragraph 226, it will be seen that a great many of these works may be regarded as revenue-sustaining rather than as revenue-creating works. They are Government, village, or private works, which have existed from time immemorial, and on the existence of which a large amount of revenue depends; the expenditure incurred on them by the State, and the obligations which it has undertaken for their future maintenance, have been incurred and undertaken, more in consideration of the revenue and of the agricultural interests depending on them, than for the sake of bringing new lands under irrigation, or of creating new revenue which would justify this expenditure as a financial investment. The expenditure incurred on these works may be regarded in almost the same light as the cost of collecting the revenue, being absolutely essential to its full realization. Such expenditure cannot legitimately be met either from loan funds or from the famine grant. All outlay on minor works of this kind has therefore been met very properly from current revenue or the ordinary irrigation grant.

248. *Transfer to major works of all minor works with reliable capital accounts.*—But it has also been shown that there are many minor works on a different footing—works which have a capital account of their own, and a revenue account which is credited only with such revenue as may be fairly attributed to the capital outlay recorded. Some of these works fulfil the conditions of a productive work; all are essentially protective; and the only reason why they have not been classed as major works is, that all expenditure incurred on them has been met from the ordinary irrigation grant. Capital expenditure on works of this class does not appear to us a fair charge against current revenue; and we think it probable that their irrigating capacity could be greatly developed, and their productive and protective value increased, if they were treated as major works. We recommend therefore that all existing minor works, for which both capital and revenue accounts are now kept, and the revenue accounts of which can be accepted as indicating, with reasonable accuracy, the true return due to the capital expenditure, should be transferred to the class of major works, whether they actually fulfil the conditions of a productive work or not. We also desire to repeat the recommendations made in paragraph 583 of the Report of the Famine Commission of 1898, that all new minor irrigation works which will form no integral part of existing minor works, and which are likely to cost more than Rs. 50,000, should be sanctioned as major works, so that current revenues may be relieved of the cost of their construction. It is not necessary that a separate account should be kept for each work. For purposes of account it may often be possible to group together all the works in the same district or some other convenient area.

249. One consequence of the adoption of the former of these recommendations will be, that the public works debt will be increased by the amount of

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the direct capital outlay on the minor works to be transferred to the class of major works, the general or unproductive debt being decreased by the same amount. We understand that when it was decided to exhibit separately, in the annual Finance Accounts, the amounts of the non-productive and public works debt, it was proposed to include in the latter the direct capital outlay on all irrigation works for which capital and revenue accounts were kept, whether the outlay had been met from loan funds or from current revenue, on the general consideration stated in paragraph 230. All works of which the capital cost was to be included in the public works debt, were to form a distinct class under the name of 'major works.' Owing, however, to the uncertainty that then existed as to the reliability of the capital and revenue accounts of many irrigation works, the cost of which had been charged against revenue, it was considered advisable to exclude all such works from the new class of 'major works,' and to class them, as well as all works for which no capital accounts were kept, as 'minor works.' It has thus happened that the term 'major works,' includes productive and protective works only; but there appears to be no real reason why irrigation works, charged against revenue, which fulfil the essential conditions of a major work, *viz.*, that reliable capital and revenue accounts are maintained, should not be transferred to that class, and the capital outlay incurred on them included in the public works debt. We understand that the Secretary of State has recently sanctioned the transfer of one important work of this class, the Upper Sutlej Inundation Canals, from the class of minor works to that of productive works. This work fulfilled all the conditions of a productive work; but we think that, if our previous recommendation to abolish the distinction between productive and protective works is accepted, all minor works which have reliable capital and revenue accounts might with advantage be transferred to the class of major works, even if they do not fulfil all the conditions of a productive work.

250. *Capital accounts of minor works.*—As a corollary of these proposals, we would suggest that no capital accounts should be maintained for those minor works which now have them, but which cannot be transferred to the class of major works owing to the unreliability of the capital and revenue accounts hitherto maintained, or to the difficulty of making them reliable. Such works should be transferred to the sub-class of minor works for which only revenue accounts are kept. It is useless to maintain capital accounts which are altogether misleading. There is a precedent for the action recommended, in the case of the Lower Sutlej and Chenab Inundation Canals, the capital account of which was recently abolished under the orders of the Government of India. These canals were taken over by Government on the annexation of the Punjab, and have since been maintained; but the capital outlay recorded against them, during the 36 years they were under Government management, amounted to Rs. 1,33,825 only, most of which was incurred in the construction of such works as bridges or inspection houses; the area annually irrigated was about 300,000 acres and the net revenue creditable to the works, after deducting all expenses of management, averaged Rs. 2,00,979. Thus, as long as the capital account was maintained, a return was shown averaging 196 per cent. on the capital outlay, which was of course wholly fictitious and misleading. This is a good instance of the unreliability of the capital and revenue accounts of some minor works.

251. *Simple classification now proposed.*—If these proposals are accepted, the classification of irrigation works will be greatly simplified; and it will be more consistent and rational, and more intelligible to non-experts in irrigation finance. In place of the classes and sub-classes previously shown (paragraphs 225 and 226) there will be the following:—

I. Major works; to include all works for which reliable capital and revenue accounts are kept, whether the capital cost has been met from loan funds or the famine grant, or from current revenues.

II. Minor works; to include all works for which capital accounts are not kept, and to be sub-classed as follows:—

(*a*) Minor works for which continuous revenue accounts are kept.

(*b*) Minor works for which revenue accounts are not kept.

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With regard to the sub-classes of minor works, continuous revenue accounts should be maintained for almost all minor works; but if they are 'true minor works,' that is, works on which expenditure has been incurred more for the sake of protecting existing cultivation and revenue from retrogression than as revenue-producing works, the financial results will not be represented by the excess of revenue over expenditure that may be shown in the revenue accounts. The revenue will in most cases be the revenue dependent on the works, and not that which is a direct result of the expenditure incurred. The main object of a revenue account for minor works of this kind is not to show how profitable the expenditure has been, but to indicate the proportion of the gross revenue dependent on the works which has been required for its sustentation, or to prevent retrogression. Class II (*b*) will include small revenue-sustaining works which it may not be thought desirable to place in class II (*a*). The final outlay on petty works which are not expected to earn revenue, and on which no revenue is dependent, will also be accounted for under this head; as, for instance, outlay on surveys for works which have not been carried out, or the cost of carrying out boring experiments which are not chargeable to any particular work.

252. *Transfer of improved minor works to major works.*—If the classification which we have recommended be adopted, class II (*a*) will still include many works of great importance. As long as Government is contented merely to maintain and manage these works, or to introduce slight improvements from time to time as funds can be spared for the purpose, this classification is appropriate and all the expenditure required may be met from current revenue. But, as has been pointed out elsewhere in this report, great extensions and improvements are possible on some of these works, which will change their character and lead to a large increase of revenue and protection. As an instance, reference may be again made to the Lower Sutlej Inundation Canals, and to the recommendations that have been made in paragraph 53, Part II, of this report. When the proposed expenditure cannot be met from current revenues, it will be advisable to transfer these works from the minor to the major class and to open capital and new revenue accounts for them. For this purpose it will be necessary to determine the average value of the revenue dependent on the work at the time of transfer. The capital account to be opened will include no share of past expenditure, but will be debited with all the outlay incurred on the improvements proposed. The new revenue accounts will show annually, not only the total net revenue dependent on or creditable to the work, but also the amount due to old irrigation; and the difference between these will be taken as the net revenue due to the capital outlay, by which the financial results will be determined. This is no new proposal. It has been adopted in many cases, particularly in Sind, in which minor works have been converted into productive works in consequence of extensive remodelling. Hitherto, however, such conversion has only been sanctioned when it has been shown that the remodelled work was likely to fulfil the conditions of a productive work; but we think that a minor work should be converted into a major work whenever it is proposed, as part of a carefully prepared scheme, to expend larger sums on its improvement than can be met from the minor works grant, and to change its character from that of a minor into that of a major work. The expediency of incurring this expenditure will be a matter for the consideration of the authority who is empowered to sanction the estimate; but when sanction has been accorded, the transfer to major works should follow as a matter of course. The effect of these proposals, if accepted, will be the gradual transfer of all the more important minor works, and of those on which there is great room for development, to the class of major works; and the assignment to this class of almost all new works costing more than Rs. 50,000. All future capital outlay on these works will be met from loan funds, though, as a set-off against the increase of debt, the share of the Famine Fund which might otherwise be devoted to the construction of protective works will be shown as applied to the reduction and avoidance of debt.

253. *Financing of minor works.*—We have next to consider the financing of those minor works which cannot fulfil the conditions of a major work, as defined in paragraph 251, and which we have called 'true minor works.' We have already remarked that expenditure on revenue-sustaining works of this class must be

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regarded as a normal charge on general revenues, and cannot properly be met from loan funds or the famine grant. We have also expressed an opinion that, in some provinces, the obligations which have been undertaken by Government in respect of these works, have not always been liberally interpreted or very fully complied with, owing mainly to the inadequacy of the grants for minor works. We think that in many provinces more money may, with advantage, be spent on the improvement and upkeep of existing minor works of this kind, and that, in some, new obligations will also arise which will have to be met from the minor works grant; such, for instance, as the cost of experimental wells and well-borings; for, as before explained, the minor works grant covers not only irrigation, but also navigation and agricultural minor works. If the grant is relieved of the demands which have hitherto been made on it for the improvement or development of the works which we propose to transfer to the class of major works, and for new minor works likely to cost more than Rs. 50,000, it may be possible to provide for all necessary expenditure on 'true minor works,' without any considerable increase of the grants which have been sanctioned of late years. We have learned with satisfaction that the state of the finances has enabled the Government of India to increase the normal grants under this head for the year 1902-03, and that it is contemplated to give a grant considerably in excess of the normal, during the following year. These special grants should suffice to make up much lee-way in the provinces in which less attention and money have been devoted to minor works in recent years than they deserved; but we hope that there will be no great need for special grants of this kind in future, if the proposals made in this chapter are accepted.

Section III.—PROVINCIALIZATION OF IRRIGATION WORKS.

254. *Preliminary.*—The only question which remains to be considered in connection with irrigation finance is that of the provincialization of irrigation works. It has been suggested to us that if irrigation works were all provincialized, and if the Provincial Governments were allowed or required to devote all the profits that might accrue to them under the irrigation settlement to the construction of new or to the improvement of old works, there would be a great incentive to careful and economical management, followed by a considerable extension of irrigation works. We readily admit the advantage of provincializing the management of irrigation works whenever the conditions are favourable; but as regards existing works we cannot recommend that the profits which may accrue under a provincial settlement should be ear-marked for the construction of new works. The irrigational requirements of a province have no relation whatever to the profits that may be made under the irrigation contract or settlement. In one province, where these profits have been considerable, new irrigation works may not be required, or there may be other provincial needs of greater urgency. In another, where protective works are most urgently required, there may have been an actual loss on the irrigation contract. The construction of new irrigation works in any province cannot be made to depend on the profits made under the provincial irrigation contract. There is nothing to prevent a Local Government from applying the profits realized under an irrigation contract to the extension of irrigation; but it is unnecessary to insist that they should be applied to no other provincial object, or, on the other hand, to limit expenditure on new works to the amount of such profits. There is at present no difficulty in obtaining funds for new major works outside the provincial contracts. In the only province in which the provincialization of all irrigation works has been at all strongly advocated, it certainly cannot be said that less funds have been granted by the Supreme Government for the construction of new works than would have been available if the works had been provincialized. The provision of funds for new works of any importance must depend on the merits of the works proposed, or on the needs of the province, and not on the profits that may accrue under a provincial contract. So far, therefore, as existing works are concerned, we shall confine our remarks to the question of provincializing those which have not yet been provincialized, without further reference to the suggestion that the profits accruing to the Provincial Governments should be reserved exclusively for irrigation works.

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255. *Difficulties in provincializing productive works.*—Generally, we are of opinion that the advantages of provincialization or decentralization are likely to be as fully marked in the management of irrigation works as in any other branch of provincial administration. We consider also that these advantages would be much greater if the term of provincial settlements could be lengthened; but this is a question of general administration which it is not within our province to consider. There are, however, difficulties in the way of provincializing all existing irrigation works. There is, in the first place, the difficulty, which exists in most provinces, of correctly estimating the average financial results of irrigation works for the term of the proposed settlement—a difficulty which will be aggravated if longer term settlements are introduced. It is perhaps on this account that the only provinces in which productive works have been provincialized are Bengal and the United Provinces. In the former no new productive works have been constructed since the canals were provincialized; and, although all the existing works had proved unremunerative, it was not difficult to form a fair estimate of the normal return. In the United Provinces, the only new work of importance is the Fatehpur Branch of the Lower Ganges Canal which was opened in 1899; but the returns from irrigation works have been liable to great fluctuation, and this forms the second difficulty in the way of provincialization. It may be possible to forecast with fair accuracy, for the purpose of a provincial settlement, the average net revenue during a series of years; but, if this revenue form a considerable proportion of the provincial revenue, serious deviations from the normal may for a time tend to embarrass the provincial finances. This difficulty was experienced during the first provincial settlements in the United Provinces; but it has been met by framing the current settlement on the basis of an equal division of net revenue between the Imperial and Provincial Governments.

256. *Provincialized minor works.*—Minor works have been provincialized in Bengal, the United Provinces, Madras, and Burma. The minor works in Bengal are, with the exception of the Saran Canals which have been practically abandoned, navigation and agricultural works only, the provincialization of which presents no difficulty. The minor works in the United Provinces are also of a character well suited for provincialization. Those in Madras and Burma are mainly of the kind to which we have applied the term 'true minor works.' The revenue dependent on them is almost exclusively land revenue, the provincial share of which follows the proportion of the whole land revenue which is assigned to the province under the current settlement. All works of this kind may very properly be provincialized; for provincialization in such cases really means provincialization of expenditure, or an assignment to the province of a certain sum for the upkeep of the works. But the sum assigned to the Madras Presidency is not sufficient for this purpose; and it is therefore inadequate to cover, without detriment to existing works, any considerable expenditure on new works of the kind hitherto classed as minor works, but which are really intended for the extension of irrigation to unprotected areas. This difficulty would, however, be met by treating such works as major works in accordance with our present recommendations (paragraph 248). As already stated, the few provincial irrigation works in the Punjab are works which have been constructed by the Local Government out of provincial revenues since the system of Provincial Accounts was introduced, and they are not, as in other provinces, works formerly Imperial which have been provincialized. In Bombay, the only provincial work is one that was provincialized for special reasons; but if the Gokak Canal is extended, the present provincial work will, no doubt, be merged in the larger works and will then probably become Imperial.

257. *Further provincialization of existing works probably advisable in certain cases.*—Although in the case of all existing provincial works the conditions have been favourable, or there have been special reasons for provincialization, and although no works classed as protective, have hitherto been provincialized, we see no reason to anticipate any great difficulty in provincializing all existing irrigation works throughout India, whether major or minor, if this be considered desirable; and we certainly see no reason why protective works should remain Imperial in those provinces in which productive works have been

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provincialized. It would probably, however, be advisable to provincialize the major works in the Punjab, on the basis, adopted in the United Provinces, of a division of surplus net-revenue between Imperial and Provincial. But, although we favour the principle of provincializing all existing works, we do not recommend that it should be pressed on Local Governments who are at present unwilling to adopt it.

258. *Provincialization of new works.*—The question of the provincialization of new works, to be constructed hereafter, presents many difficulties. As far as productive works are concerned, we find that fifteen years ago the Government of India in their Financial Department Resolution No. 2009, dated 23rd March 1878, contemplated the construction of canals by Provincial Governments, from loans raised by debentures or advanced from the Imperial treasury. But it was subsequently pointed out by the Finance Committee that works constructed from such loans involved during construction a heavy charge against provincial revenues, without any compensating return on account of interest on the borrowed capital. And, with a view to postponing the liability for the interest charges till the work became productive, the Committee suggested the following amended procedure :—

"*3. Proposed procedure.*—A province, which desires to commence a new irrigation project, would, under this proposal, submit to the Government of India an estimate of the amount required for capital construction year by year, and for annual maintenance charges, both during construction and for a period not exceeding ten years from the opening of the irrigation work, after the expiry of which period, according to the estimate, the revenue should be sufficient to meet both maintenance charges and interest on capital. Upon this basis the Imperial Government would undertake to furnish year by year the money required for capital construction ; but would, meantime, bear all revenue charges, including that for interest on capital. At the term fixed (or, at the option of the Provincial Government, at any earlier date) the work would become either partly or wholly provincial, as the Government of India may decide. This procedure can be applied not only to future new works, but (*mutatis mutandis*) to works which are now under construction and have not yet attained to their full bearing.

"*4. Arrears of interest.*—It seems on the whole advisable that the responsibility for the interest, which accrues during construction and until the taking over of the work, should fall ultimately on the Local Government, and it can hereafter be determined whether these arrears of interest should be treated as a loan (as between Imperial and Provincial) and recovered by annual instalments, or should be added to the capital account of the work."

Every such arrangement, the Finance Committee contemplated, "would be a separate and subsidiary one, not part of the regular Provincial contract : *first*, because it is obvious that its duration must be fixed on special considerations and may or may not be the same as that of the regular contract ; *second*, because it must be a stipulation that the money allotted under the arrangement is appropriable only to the particular purpose defined and cannot be used for any other."

259. *Sirsa Branch of Western Jumna Canal.*—We have been informed that the Punjab Government have accepted financial responsibility for two projects,—the Sirsa Branch of the Western Jumna Canal and the Jhelum Canal—in accordance with this scheme ; but neither of these works has been provincialized, either as part of the regular provincial contract, or as a separate and subsidiary one as recommended by the Finance Committee. The Jhelum Canal has only recently been opened, and the question of provincializing it has not yet been raised. The Sirsa Branch was opened in 1892 and completed in 1895. The work has been so remunerative that all arrears of interest were cleared in the year 1896-97. Its provincialization, especially if effected outside the regular provincial contract, would have been very advantageous to the Local Government, but this never appears to have been proposed ; and indeed a separate revenue account for the Sirsa Branch is no longer maintained, as it was merged in the general account of the Western Jumna Canal in 1899-1900, after it had been fully demonstrated that the conditions of a productive public work had been more than fulfilled.

260. *Fatehpur Branch, Lower Ganges Canal.*—The only other productive work for which a Local Government has accepted financial responsibility, prior to its construction, appears to be the Fatehpur Branch of the Lower Ganges Canal. This has been provincialized, like all the older productive works in the United Provinces, as part of the regular provincial contract, the charges for

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interest on capital being met from provincial revenues. There has been no proposal to make a separate and subsidiary arrangement outside the regular provincial contract.

261. *Scheme for provincializing new works.*—It thus appears that the policy recommended by the Finance Committee of 1886 has not been carried out, and that there is no example by which its efficacy can be tested. The proposals are also inapplicable in their present form to works which are not likely to fulfil the conditions of a productive work ; and it is to be apprehended that the majority of the works to be constructed in future will be of this class. It would not be difficult, however, to modify the proposals, so as to limit the liabilities of the Provincial Government in respect of interest, if it is considered desirable to apply them to the case of protective works. Such an arrangement would no doubt have great advantages in practice. It would enable Local Governments to obtain the funds required for the continuous and systematic execution of all feasible protective works needed for the province, subject to their undertaking a definite but limited financial responsibility. The acceptance and enforcement of this responsibility would necessitate the exercise of great care and caution in the framing of estimates for the works and of the forecasts of financial results, and also a close annual scrutiny of the results actually attained, which would certainly make for economy and efficiency. It would ensure a bolder, but at the same time a more tentative, rate of progress than would be possible if the Local Governments were under no sense of financial responsibility in recommending new projects ; while it would quicken their interest in the rapid execution and successful development of the works, and in the realization of a fair amount of revenue from the people benefited by them. The main initial difficulty will be to determine the amount of net-revenue, or the rate of interest on the capital cost, for which the Provincial Government must be held responsible. This will probably vary for different provinces. If it is fixed too high, there will be loss instead of profit to the Local Governments, who will have to avoid incurring further obligations, however great the necessity, or the system will break down. To meet this difficulty, we think that the amounts for which the Local Governments may be asked to accept provincial responsibility after the works have come into operation, should, in the first instance, be fixed as low as possible. In some provinces, it may suffice to limit the responsibility to the payment of the working expenses ; and in all, the limit should be fixed well below the return on capital cost which the works may reasonably be expected to yield. This moderation will be necessary in order to prevent the system from breaking down in the earlier stages ; and the greater profits that may accrue to the Provincial Governments will not be thrown away, as they will either be actually devoted to the construction of new works, or form a reserve on the strength of which the Local Governments will be able with greater confidence to extend their operations.

262. *Provincialization should include indirect revenue.*—In order to make the scheme really effective in those provinces in which the irrigation revenue is wholly or mainly indirect, in the form of enhanced land revenue, it will be necessary to provincialize the whole of the indirect revenue that may be due to the works included in it, or to make other arrangements for crediting the provincial account with the whole of the revenue actually created by the works.

263. *Provincialization advisable where new works contemplated.*—We realize that the question of provincializing new projects, on such terms as will ensure real provincial responsibility, is beset with difficulties, and that it must be considered from other points of view than that from which we are able to regard it. The details of the scheme which we have indicated will probably require some modification or amplification before practical effect can be given to it. We consider, however, that a scheme based on these principles may, with advantage, be applied to any province in which an extensive programme of irrigation works is contemplated.

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CHAPTER IX.—METHODS OF CHARGING FOR WATER.

264. *Water rates in Northern India.*—Throughout India the basis of charges for water supplied by State works for irrigation, is the area irrigated; but different systems of charging are in operation in different parts of the country. In Bengal, the United Provinces, the greater part of the Punjab, and on all of the newer irrigation works of Bombay (excluding Sind), a water-rate, varying with the kind of crop grown, is charged per acre watered, apart from the land revenue assessment. This is known as the occupier's rate. It is paid by him in return for the water supplied and forms part of his expenses of cultivation. It is for many reasons impossible to fix this rate so high as to leave the occupier no larger margin of profit than would suffice to induce him to take water, so that the introduction of irrigation is generally followed by an enhancement of rents. In provinces, the revenue of which is not permanently settled, a share of this increase is taken by Government at revision of settlement, either in the ordinary way, or by the imposition of an owner's rate, which, although payable by the owner, is, like the occupier's rate, levied on the area actually irrigated during the year. The owner's rate may be imposed during the currency of a settlement on lands which have been brought under irrigation after the settlement was made.

265. Where a land revenue is permanent, as in the districts of Bengal, it is not permitted to increase it on account of the water advantages acquired from the construction of new irrigation works; and as the occupier pays the water rate, the landowner reaps all the benefit of levying an increased rental, without bearing any part of the burden thrown on the tax-payer by the construction of the works. It will be seen (II, 442) that in the district of Saran, where there has been a strong wish expressed for irrigation, accompanied by the assurance that water will only be required once in four years, there has been a proposal to meet the cost of providing irrigation works by levying a cess on the district, or on that portion of the district that is benefited.

266. *Irrigation revenue in Sind.*—In Sind, where there is but little cultivated land that is not irrigated, the charges for water are not taken in the form of an occupiers' rate, but are included in the land revenue assessment. In this province the land revenue is fluctuating, and is levied only on the lands actually cultivated during the year. Nine-tenths of the assessments on irrigated lands are regarded as due to the canals and are credited to them in the accounts as irrigation revenue. It is therefore practically a water rate, varying with the area actually irrigated and the kind of crop sown, although taken in the form of land revenue. This Sind system somewhat resembles that which is in force in Egypt, where it is impossible to cultivate without irrigation, and where the land tax is levied only on land which gets irrigation by flow during the Nile flood.

267. *Assessment in Madras and on old works in Bombay.*—In Madras separate water-rates are charged on dry lands watered by newly constructed works or extensions before the area of irrigation has become established, and in a few other special cases. But, in general, the irrigation charge is consolidated in the land revenue assessment. In Bombay also, on the older works of the Presidency proper, the charge is consolidated. This system is evidently the most simple, and where the area irrigated is subject only to slight changes, as in the rice flats of the Madras deltas, and in the *ayakats* watered by the innumerable tanks of Southern India, it is probably the best system. It has, moreover, an advantage in elasticity of application over that pursued in Northern India. The Settlement Officer in Madras and Bombay takes into account the whole circumstances of each survey field, the productiveness of the soil, its proximity to the market, etc., and he may fix his assessment as high as Rs. 14, or as low as Rs. 2-8 per acre on fields which have enjoyed the same amount of irrigation.

268. *Sale of water by measure.*—There is one defect which is common to all the systems which have been described above, in that no inducement is offered

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under any of them to the cultivator to economize water, and to see that it is not wasted between the Government channel and the field. It has long been an attractive idea to many irrigation officers that the true method is to sell the water by measure at the bank of the distributary channel, on the assumption that under this system the self-interest of the cultivator would induce him to make every effort in economizing water. In 1854 Sir Proby Cautley wrote *:—

"It is to this adjustment, to this determination of a unit by which water can be equally distributed, and to the invention of a machine by which such units can be discharged in a given time, that we have to look for a fair and economical expenditure of the canal supply."

The late Colonel Baird Smith, in his interesting work on Italian irrigation, described how he found this system working in Lombardy; and on his return to India as Superintendent-General of Irrigation in 1854 he introduced a modification of the Italian system on the Ganges Canal where it was tried for several years. The system was to sell the water by *paimana*, or module; and although no simple form of sluice had been invented which would give a uniform discharge in the village channel under a varying head of water in the distributary, still it was thought that something sufficiently correct for practical purposes had been arrived at.

269. From the beginning it was a failure, as it was bound to be even if the module had given accurate results, which it did not. The cultivators on the Ganges Canal were not used to irrigation, and looked on the module with considerable suspicion. They had no idea of the quantity of water required for the irrigation of an acre. Worst of all there was no effort made, nor could it be made, to sell to each peasant cultivator the small measure required for his small plot of land; and there was not that co-operative spirit among the people which would have enabled them to partition out to each holding its proper share of the measure sold to the village. After a few years' trial the system was abandoned, and it has never since been restored.

270. *Leases on the Jumna Canals.*—With the same laudable object of avoiding all unnecessary interference on the part of the canal establishment with the domestic details of the village, and of encouraging the economical use of water, the method was adopted at an early period on the Western Jumna Canal of selling water by contract, on leases extending up to 20 years; the landowner agreeing to pay a fixed price for a water-course head with a given area of opening. But at this time various changes and improvements were going on. It would have been fatal to have stereotyped for a long period of years the existing conditions of each irrigation outlet, and the system was abandoned.

271. Again on the Eastern Jumna Canal, where things were supposed to have arrived at some finality in 1865-67, a great many three-years' leases were entered on; each lease being for the irrigation of lands within the village area, the number and position of the village outlets remaining unchanged. Very favourable terms were offered to the cultivators, reductions being allowed of from 14 to 18 per cent. of the average sum they had paid as water rate during the preceding five years. The leases were readily entered into, but at the end of three years all declined to renew them, owing to the impossibility of distributing the water and of adjusting among the different cultivators the sum to be paid by each. The system then of recording every season, by the aid of village maps and registers, the areas of all the fields watered and the crop grown is still in force in the United Provinces and in the Punjab.

272. *Long term leases in Bengal.*—Although no attempt has been made during the last 35 years to persevere with or to revive the system of leases in Northern India, conditions in Bengal have led to the gradual evolution of the system which is to be found on the Sone and Orissa Canals. In this province, where climatic conditions render it very doubtful whether the cultivator will, in any particular season, take water for his field or not, successful attempts have been made to induce him to take a lease for five or seven years; and the whole

* Report on the Ganges Canal, Vol. I, page 430.

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method of distribution and canal administration has been adapted to this system. The system pursued on the Sone Canals, and that which was tried on the Eastern Jumna Canal, are alike in this respect that the payments to be made are expressed in terms not of a unit of volume but of a unit of area, and are in fact a compounded occupier's rate to be paid in consideration of a supply of water adequate for the irrigation of lands within certain boundaries. On the Sone Canals the land is partitioned out into well defined blocks, never overpassing the boundaries of the village. On the Eastern Jumna Canal the boundaries were in every case those of the village itself. But here the systems essentially differ. On the Sone Canals the volume supplied is calculated to be sufficient for the irrigation of every acre in the block within a certain number of days, and it is the duty of the Canal Officer to see that this supply is maintained, for the popularity and the success of the lease system depends upon it. There is then no inducement to the cultivator to economize water, for he has as much as he requires; and if he parts with it to irrigate a neighbour's field outside of the block he is liable to a fine.

273. On the Eastern Jumna Canal hardly any village irrigated in any one crop more than half of its cultivated area. There was, therefore, great inducement to the cultivator to economize water, and to spread it over other fields within the village boundaries. Indeed, such a wide scope was here given for economizing water that practically speaking it became a system of charging by volume. Both systems have the one advantage in common that they obviate the necessity for annual assessments of water rate on the crops and area irrigated. The Sone Canal system is also very interesting as being one which has been gradually developed in accordance with local requirements, and there is evidence that its popularity is steadily increasing. The readiness of the cultivator in Bengal to enter into long term leases justifies the hope that one of the difficulties connected with a volumetric system of charges may not prove to be serious.

274. *Charges by volume.*—The advantages of charging by volume are sometimes exaggerated, but they are nevertheless so great and unquestionable that all who are interested in irrigation are hopeful that it may be possible sooner or later to introduce such a system wherever canal irrigation is practised. Before, however, considering the subject further it is necessary to form a clear idea of what is meant by charging by volume. There may be said to be two systems—the charge by meter, and the charge by module.

275. *The "meter" system.*—Many of those who advocate volumetric charges have in their minds a system under which the users of water will be charged according to the number of units of supply (say the foot-acre, or 43,560 cubic feet) actually used, the quantity being measured on a self-recording *meter* at a distance not very far removed from the field to be watered. In the same way Municipalities or Public Companies charge dwellers in towns for water used for domestic purposes, or for gas, or electrical energy. This may be called the "meter system." But for reasons which will presently be explained it is wholly inapplicable to irrigation in India, except in a few special cases in which the water is distributed over a comparatively small and compact area situated in close proximity to the source of supply. A good instance of this is a moderate sized tank of the kind that we have proposed for the Central Provinces, constructed for the storage of water to be issued as required for irrigating the lands in the immediate vicinity, when there is a prolonged break in the rains, or when the rains begin very late or end very early. In such a case there would be no real difficulty in arranging that the sluice should pass out a constant supply (say 8 cusecs), whatever the level of water in the tank above a certain minimum, except that of providing a reliable man to control the regulation. A charge for the use of this full supply, at so much an hour, might then be fixed; and all the occupiers who were entitled to the privilege might be allowed to take it in turn or on application, for whatever periods might be required, on payment of the prescribed rate. As another example may be cited the case of a large steam pump erected on the bank of a river, or other suitable source of supply, for the irrigation of crops for which there might be a fitful demand. The discharge of the pumps could be easily regulated to some constant quantity; and the

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manager would probably introduce a scale of charges per hour for the use of a full bore supply, the value of which the cultivators would have no difficulty in appreciating after a little experience.

276. In both these cases there is an element of difficulty which deserves notice, as it occurs in a greater or less degree in all systems of charging by volume. The value of a unit of supply delivered at the sluice of the tank or at the pumping station, is very much more when applied to lands in the immediate vicinity than when taken to lands two or three miles away. The cultivator of the latter cannot afford to pay as much per unit of supply as the cultivator of the former, for it will irrigate a much smaller area. When the whole area under protection is not very large, the difficulty would probably be met by fixing a uniform rate of charge with reference to the average length of lead; but when the area is large a system of payment by volume is likely to break down, unless there is a sliding scale of charges, which should vary inversely with the distance of the fields to be irrigated from the point at which the supply is measured.

277. There are probably a few works on which a system of charging by volume of this kind could be introduced without much difficulty. They would offer a valuable means of testing the advantages claimed for a volumetric system of charge; and, if all these advantages were realized, they would be equally valuable as a means of measuring the increase of efficiency which might be expected on other irrigation works if charges were based on the supply used and not on the area irrigated. But the field in which the meter system of charging can be introduced is very limited.

278. *Meter and module systems compared.*—The basis of the meter system of charging for water is that the cultivator pays a certain sum per unit. In a rainy season one unit of water may be sufficient to mature his crop. In a dry season it may require five units; and in the latter case he will pay five times as much as in the former, although the value of the crop obtained may be no greater and will often be less. In the module system the cultivator pays a rate for the volume of water allowed to pass through a sluice, at prescribed intervals of time, in sufficient quantity to mature his crop, the discharge of the sluice bearing a certain proportion to the area to be irrigated. In a rainy season, if he has taken one watering for his field, he will have to pay the same as he would in a dry season when he may require five waterings. He pays, in fact, at a moderate and uniform rate per unit for the supply which is placed at his disposal, and not, as under the meter system, at a much higher rate for the amount which he actually takes. Under the latter system, he might in a dry season have to pay more than the crop was worth; while in a wet year he might pay only a trifling sum for a single watering, which nevertheless was absolutely necessary to save a valuable crop that he might not have sown at all, but for the knowledge that he could get the water when he wanted it. On this ground alone the module system, with its lower unit rate of charge, is certain to be more acceptable to the cultivator than the meter system. But there is another reason which renders the latter wholly unsuitable for general adoption.

279. On any extensive canal system the principal care and duty of the irrigation officer is to ensure the regular delivery at the extremities of all his distributaries (either simultaneously or according to a fixed system of rotation) of the supply required for the irrigation of the crops or the preparation of the land for sowings. When arrangements have thus been made for sending water over a distance, which may often amount to over a hundred miles, for the use of a particular water-course, it is obvious that it ought to be paid for, whether the owners of the water-course elect to take the whole of it or not. A very large percentage of the supply actually rendered available at the head of the water-course has been unavoidably lost in transit, and when water has passed a certain distance down a distributary, it cannot be sent back again or utilized elsewhere, if those to whom it has been allotted decline to take it. The case is altogether different from those which have been considered in paragraphs 275

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and 276, in which the source of supply is close at hand, and can be readily tapped to meet the requirements of a consumer on application to the man in charge.

280. For this reason the meter system is quite inapplicable to large irrigation works, and the module is the only possible system of charging by volume; the function of a module being, not like that of a meter to measure the volume of the supply passing through it, but to *control* it, so that when fully open the discharge will be constant and will not rise above or fall below the rate at which it is set, whatever variations may occur in the level of the water in the supply channel, or in the drawing capacity of the water-course, which can very often be considerably increased at the will or by the action of the owners. The consumer could if he pleased reduce the discharge, or close the module altogether; but he would not ordinarily be entitled to any reduction in the charge made if he failed to utilize the whole supply for which the module was set. We are convinced that this is the only system of charging by volume suitable for India, except in the special cases referred to already; and it may be added that in all countries in which an attempt has been made to charge by volume—in Italy, in Spain, and in America—it is the module and not the meter system which has been adopted.

281. *Difficulties in obtaining a module.*—It is often supposed that the main objection to the module system is the difficulty of obtaining a satisfactory module. It is of course obvious that it is impossible to enter into an engagement with each individual cultivator, or to erect a module on every holding. On the other hand, charges by volume cannot be recovered from a larger unit than the village; for there would be great and insuperable difficulties in distributing either the charge or the supply between the members of two or more villages. But a village is often irrigated from one or both sides of two or more independent water-courses, according to the configuration of the ground, so that the unit for the purpose of volumetric charges must always be the water-course, and each water-course must be supplied with its own module. There is another reason which limits the size of the area which may be supplied from one module, to which allusion has already been made in paragraph 276—a uniform rate cannot be charged per unit of supply, when there is very great variation in the lengths of the channel leading to the consumers' lands.

282. The construction of a module in itself presents no great difficulty, if a reasonable amount of attention can be given to its working, and too great a degree of accuracy is not insisted on. Mr. Kennedy, Superintending Engineer in the Punjab Irrigation Branch, who has recently studied the American system of irrigation on the spot, has told us that the system of charging by module is in general use there, and that the modules, although not very accurate, give satisfaction. But they are applied to channels of much greater capacity than that of the ordinary Indian village water-course, which ordinarily varies from half a cusec to four cusecs; and the American farmers are much better able to look after themselves and each other, and to satisfy themselves as to the fairness of the distribution and the correct working of the modules, than the Indian rayat. In Northern India there would probably be on an average five modules in every irrigating village, scattered all over the country, and under very little supervision. They would have to work with a very small and often a hardly appreciable head; their working must not be affected by silt; and they must be so designed that they cannot easily be tampered with. Clockwork and similar complications must be regarded as out of the question. All these difficulties are considerable, but we are not prepared to say that they cannot be overcome. If it were once decided to take up the question of volumetric distribution in earnest, we have no doubt that the ingenuity of the irrigation officers and of other inventors would be equal to the occasion; and that a satisfactory module could be devised, if all conditions and requirements were clearly understood. The fact is that no serious attempt has hitherto been made to introduce modules, because it has no doubt been felt that the want of a good module is one of the least of the difficulties in the way of a volumetric system of assessment.

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283. *Objections by cultivators.*—The first of these difficulties is the distrust with which any change in the present system would be regarded by the Indian cultivator, who knows nothing about the quantitative determination of the supply of flowing water, but has been accustomed from time immemorial to pay a revenue dependent on the area and nature of the crops which he cultivates. A water-rate based on these factors is intelligible to him; a contract for a given supply of water is not. He does not know how far the supply for which he contracts may be curtailed or tampered with by the petty officials who must be employed even under a system of volumetric charges, or how he is to bring complaints of short supply to the notice of the canal officers, and to establish them. Then there is the question of the internal distribution already alluded to in paragraph 271. The cultivator may find himself called on to pay a larger share of the sum charged on the water-course than is represented by the volume that he has actually received, for he cannot always hold his own against his neighbours. Under the present system, however much he may be deprived of his fair share of the village supply, he is only called on to pay according to the area which he has actually irrigated, and he can claim remissions on that if the crop is below a certain standard. He can understand the principle of "no crop, no charge," which is now followed as far as possible in canal administration; but he will have no confidence in a system in which his liability for water-rate will be wholly independent of the area and quality of his crop.

284. *Difficulty in devising a scale of charges.*—The canal officer will have to meet another difficulty, which is presented by the problem—"given all details of the supply, the rainfall, the irrigated area, and the revenue from water-rates during a series of years, to propose a scale of rates of charge per unit of volume which shall secure Government against loss of revenue, and shall be acceptable to the cultivator." The problem has only to be stated for the inherent difficulties to become apparent. In practice, no doubt, it would be necessary, as in the case of the Eastern Jumna Canal experiment, to reconcile the cultivator to the new order of things by proposing charges which involve a considerable loss of revenue to Government—a loss which would be continuous until the scale of charges could be revised; and revisions could, for obvious reasons, only take place at long intervals.

285. *Distribution by module.*—For these reasons we think that, even if a perfect village module could be brought out to-morrow, the day on which a volumetric system of charges could be introduced into India would be distant. But we do not say that it will never come if systematic efforts are made to prepare the way for it. The first step to be taken is to establish in a selected canal, or section of a canal, a *volumetric system of distribution*, the present system of assessment remaining unaltered. Mr. Kennedy, who has devoted a great deal of attention to this subject, has designed and constructed a module for the head of a distributary, which can by a simple adjustment of weights be set to pass any prescribed supply, within certain limits, into the distributary, whatever the variation in the canal supply or in the drawing power of the distributary. He says that this module has now been under trial for two or three years, and that it may be relied on to pass the particular supply for which it is set within 2 per cent. We have no independent evidence of the practical efficiency of this particular module; but, however this may be, we think that there should be no difficulty in controlling the supply entering a distributary to within 5 per cent. of whatever may be prescribed. When the supply entering the head of a distributary can be controlled within these limits, the first great step has been taken to secure regularity in distribution. The next step will be to construct suitable modules at the heads of all the branches and minors taking off from the distributary, so that each shall receive a share proportioned to its requirements. The third step would be to construct the modules at the heads of all water-courses, the volume to be charged for depending on the lengths of the periods during which the head of the distributary was open. The periods of flow and closure would be regulated in accordance with a prescribed programme, and would be well known to every cultivator. The present system of assessment should not be changed; but after a few seasons of regular and systematic working, the cultivators would understand what was meant by an hour's working of their modules at full bore.

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After a time they might be allowed the option of contracting for the season or for a number of seasons; the terms of the contract being a full bore for so many days in the week or other suitable period; the length of the time being subject to rateable reduction when the supply in the canal was insufficient; but each reduction to carry a proportionate reduction in the amount to be paid. If the system became popular, the change would in course of time be made voluntarily, or it might be made compulsory when it was found that the majority of the cultivators preferred it.

286. If satisfactory modules can be devised, it appears to us that it is only in this way that the present system of assessment by area can be changed for one of charge by volume. It is only by proceeding gradually, and enlisting public opinion in its favour, that such a change can ever be introduced in India. It is probable, however, that distribution by modules in the way proposed would result in great economy, even if the people preferred to adhere to the present system of assessment. The more systematic the distribution, and the greater the certainty of the cultivator as to the supply he will receive, the greater will be the efficiency of the canal, whatever system of assessment be adopted. The attention which has been paid of late years to the method of working distributaries, and especially to the proportioning of outlets to requirements, has been followed by remarkable improvements in the duty and expansion of revenue. But still better results will be obtained when the distribution is regulated by more accurate measurements, such as are now recognized as essential to real progress in every department of practical science, and in a great many industrial undertakings.

287. *Modules on Sone Canals.*—We have already pointed out that there is no effective inducement to the peasant on the Sone Canals to economize water; as he cannot utilize any portion of the supply at his disposal on lands outside the boundaries of his block. These boundaries cannot be extended or removed at present, because the supplies to which these blocks are entitled have never been quantitatively defined. Until this is done a true system of charging by volume cannot be introduced. If, however, modules were introduced on these canals, and the quantities to be assigned to each block at different periods of the season were definitely fixed, it should be possible after a season, during which the cultivators would have learned to understand the new system, to grant future leases in terms of the volume to be supplied, and to fix no boundaries to the area to which water might be supplied.

288. *Application of the method of volumetric charges to other provinces.*—A system of long leases based on charges by volume will be very suitable for some of the works in the Bombay Deccan, as soon as sufficient experience has been gained in the working of modules to enable the cultivators to understand to what quantities of water they are entitled. The substitution of charges by volume for the present system of a consolidated wet assessment, such as obtains in Madras, would involve such a change in the whole system of land revenue assessment that we cannot recommend it, at any rate on existing works. We doubt also whether a system of volumetric charges would ever be suitable for Sind, where the supplies to the canals are subject to great fluctuations.

289. *General conclusion.*—Our general conclusion on this question is, that the module system of charging by volume cannot, in spite of all its advantages, be safely introduced in India, until a system of distribution by modules of the type which it may be proposed to use has been in force for a time sufficiently long to enable the people to understand what is proposed; and that even then the change in the system of assessment should not be forced, but be introduced gradually as the people learn to appreciate its advantages. It is, however, an end to be aimed at; and irrigation officers should be encouraged to design and experiment on modules which will be suited to the conditions to be met with in practice, until the work of distribution can be carried out with all the regularity and certainty which is essential to the success of any scheme of charging by volume.

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290. We recommend that strenuous and continuous efforts be made to perfect the system of distribution, by the use of modules and other means. We believe that this will be followed by an immediate increase in the efficiency and protective value of the canals, and will prepare the way for the gradual introduction of the desired consummation—a system of assessment by volume. But, although this end is one to be kept steadily in view, its attainment is not a matter of urgency as long as canal administration is conducted on the lines which will ultimately lead to it. Although we fully appreciate all the advantages which may be claimed for a volumetric system of assessment, we consider that the objections to the system of assessment by area are not so serious as to call for immediate removal. The wilful or preventable waste of water in private water-courses, which is often attributed to this system, occurs chiefly when there is a slack demand and ample supply, or when the water that is wasted could not be utilized for extending irrigation in the adjacent area. The incentive to economize water on such occasions will not be much greater under a volumetric system; for, as we have shown, no system is practicable which would involve a reduction of charges when water, supplied to the extent contemplated in the agreement, is not utilized. In times of intense demand and insufficient supply, which afford the supreme test of the efficiency of an irrigation work, the cultivators may, even under the present system, be relied on to spare no effort to make the water go as far as possible. At such times the increased efficiency of the canal will depend more on the certainty and regularity of the distribution, which the more extensive use of modules will induce, than on the additional incentive to economy on the part of the cultivator, which may be afforded by a change in the method of assessment. It would, no doubt, be a great advantage, both to Government and to the cultivators, if the latter could be induced to take over their supplies at the outlets, to arrange all details of internal distribution between themselves, and to relieve the canal administration of all further responsibilities and of the great expense of recording the details of the irrigation, and of making the final measurements and assessments. As long, however, as the Indian peasant is what he is, there is something to be said for a system which, in accordance with all ancient custom, makes the charge for water advantages dependent, not on the quantity of water to which he may have been entitled, but on the benefits which have actually accrued to him, and on his capacity for paying for them, as measured by the area and quality of the crops which he has irrigated and matured. We deprecate any change in this system, until the way has been prepared for it by a patient study of all the conditions on which success will depend. We think that the change should be contemplated, that the present system should not be regarded as final and beyond improvement; but we recommend that *distribution* by module should come first. Then, after a long interval, *assessment* by module may follow.

291. *Mr. Visvesvaraya's block system.*—Since the preceding paragraphs were written, we have received from the Government of Bombay an able and interesting paper by Mr. Visvesvaraya, Executive Engineer, Poona Irrigation District, in which he has worked out all the details of the long-lease block system to which we had already referred with approval in our Bombay Chapter (II, 167). The scheme proposed appears to us very complete and well considered, and although it has not yet been examined by the Government of Bombay, we think that the general principle is sound; and that, if some such system as that advocated can be introduced on the irrigation works of the Deccan, it will render them much more useful to the people and much more remunerative to Government. We hope therefore that it may be possible to give the system proposed by Mr. Visvesvaraya an early and thorough trial. We refer to it here, however, as affording an excellent illustration of the views which we have set forth above. Mr. Visvesvaraya proposes to give long leases to the occupiers of defined blocks in each village, at a certain average or all-round water-rate for every acre included in the block, the area to be put under cane or perennial crops being limited to one-third of the area of the block. So far the system is identical with the block system which we have found in force on the Orissa and Sone Canals in Bengal; but there is this difference that it is proposed to measure and regulate the supply passed into each block by

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the use of a simple module. Although the contract will be for the irrigation of a certain area, and the charge will be in the form of a water-rate on the area of the block, the supply to be passed to each block will be carefully regulated by module; and in this way a definite and easily understood standard will be set up, of the quantity of water to which the occupiers of each block are entitled in consideration of the charges levied. It is in effect the very system of "distribution by module" which we have independently recommended in this chapter; and if it can be successfully established, we have no doubt that within a reasonable time the system of assessment by volume will follow. The boundaries of the blocks may then be extended or removed; and the people will pay, not according to the areas of their blocks, but according to the quantities of water, which will form the basis of future contracts.

292. There are no irrigation works on which it is of greater importance to introduce a system of charging by volume combined with long term leases than the works in the Bombay Deccan. The cost of storage is so great, and the demand for water is so fitful and uncertain, that it is only by some such system as this that both the productive and protective capacities of the works can be developed to the utmost. We may add that there are no works on which the prospects of successfully establishing the block system are more encouraging. The system closely resembles that of the *bandharas* in Nasik and Khandesh which has been evolved by the people themselves, and is well understood throughout the Deccan; the cultivators on the Deccan works have also been long accustomed to rely on the canal officials to make arrangements for the distribution of water for their crops. What is now aimed at is a permanent or long term scheme of distribution, instead of a temporary or seasonal one; and although there must be difficulties, they will be easily overcome if the hearty co-operation of the people themselves can be relied on.

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CHAPTER X.—ESTABLISHMENTS.

293. *Necessity for increase in engineering staff.*—In every province which we have visited, wherever we have taken evidence, and made or received any proposals for the extension of works, we have been uniformly met with the complaint of the lack of engineer-officers. We have reason to think that this complaint is well founded. It has been pointed out to us that the scale which has been sanctioned for each province is insufficient for present requirements; that the actual working strength is generally much below that scale; and that matters are getting worse every year, as, owing to irregular and insufficient recruitment in the past, the number of annual vacancies exceeds the number of new recruits. We have been told not only that the size of divisional charges is much larger than formerly, but also that the Executive Engineers are assisted by a less efficient staff; sub-divisions which used to be held by engineers of English education being now in charge of subordinates or of engineers temporarily employed.

294. The sufficiency of the strength of the Public Works Department for the current duties which it has to discharge, and the adequacy of the present recruiting arrangements, are administrative questions with which we have no immediate concern; and we have not therefore considered these complaints very closely. We cannot, however, but recognize that the successful prosecution of the programme of new irrigation works which it has been our duty to propose, will largely depend on the maintenance of the *personnel* of the Public Works Department at an adequate strength; and that, if even only a portion of that programme meets with the approval of Government, it cannot be completed within a reasonable time unless the staff of engineers be largely increased; and a *permanent* increase will be required for purposes of investigation and construction, and also of subsequent maintenance and management. We need not dwell on the fatally wrong policy of spending large sums on new works and grudging the small expenditure necessary for their proper design, supervision, and management.

295. In the three northern Local Governments, and in Madras, there is a special Chief Engineer for Irrigation, who is *ex-officio* a Secretary to the Government, and who is responsible for the departmental administration of irrigation works. In Bombay there are two Chief Engineers, but only one of them is Secretary to Government, the other being in reality only a Superintending Engineer on a higher salary, whose duties are confined to a particular circle. There is, therefore, in Bombay no special Chief Engineer for irrigation alone, to exercise administrative control and to examine projects sent in from all parts of the Presidency, and at the same time, as Secretary to Government, to be its adviser on all irrigation questions. The arrangement appears to us to be open to many objections; and soon after visiting this Presidency, we addressed the Government of India, recommending that a Chief Engineer for Irrigation, with a largely increased staff of Executive and Assistant Engineers, should be appointed as soon as possible. The question of extending irrigation in this Presidency is of such great importance, and at the same time beset with so many difficulties, that we think it very desirable that there should be a whole-time Chief Engineer and Secretary to Government for Irrigation in place of a Chief Engineer holding an ordinary Superintending Engineer's charge; and, if our recommendations for works are accepted, an additional Superintending Engineer's appointment will have to be created.

296. The magnitude and importance of the new projects which have been proposed in the Punjab and in Madras will necessitate an increase in the number of Superintending Engineer's charges; and it is desirable that this should be made at once, so that the complete and exhaustive investigations required may be placed from the first under the supervision of responsible and specially selected officers. If State irrigation works are at length to be undertaken in the Central Provinces on even a moderate scale, we think that it

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will be necessary to appoint a Superintending Engineer for Irrigation under that administration, who will supervise the investigation, design, and construction of these projects. The present Irrigation Circles in the United Provinces are very large; and if new works are undertaken, and especially if the extension of irrigation in Bundelkhand is taken up, a fourth Superintending Engineer's charge must be contemplated. We have already recommended the temporary appointment of a Superintending Engineer for the purpose of preparing schemes for the extension of irrigation in the Rajputana States; and if, as we hope, a useful programme of works can be formulated which will be acceptable to the States concerned, this appointment will probably be made permanent. It may be anticipated also that there will be increasing demands, not only from Rajputana, but also from Central India and from the great Native States, for the services of engineer-officers to design and construct new irrigation works within their own borders.

297. It is thus evident that the creation of new administrative appointments, and the demand for trained irrigation officers for Native States, will of themselves necessitate a considerable increase in the strength of the engineer establishment. But this is not all. Irrigation projects, and especially those which involve the storage of water on a considerable and often colossal scale, require, as is well known, an extraordinary amount of preliminary investigation and special designing, as compared with an ordinary road or railway project, and also very close supervision in all stages of construction, for all of which a large staff of engineers will be absolutely necessary. The investigation of these projects cannot be carried on by a number of subordinates under the supervision of officers who, amid the stress of other duties, have little or no time to attend to them and their work. There is indeed a wide field for the employment of as many competent subordinates as are likely to be available in the country, and it may be hoped that the supply will increase with the demand. But their labours must be directed in investigation, and afterwards utilized in design and during construction, by highly qualified engineers, with trained powers of observation, self-reliant and resourceful, and ready at all times to undertake responsibility and to act on their own initiative.

298. Experience shows that engineers of this class can rarely be obtained unless they are admitted to the permanent strength of the department and offered an Indian career. It may be necessary at first to offer temporary engagements to the best men who can be obtained; but it will always be difficult to get in this way many men possessing the required qualifications, and we are confident that such an expedient will be found in the long run very uneconomical. If Government accept the general policy of an extension of irrigation works on the lines which we propose, there is no reason to apprehend that any immediate expansion of the permanent strength of the department will be followed within a few years by contraction, and the consequent evils of blocked promotion and forced retirements. It must always be remembered that irrigation works when completed cannot be left to themselves; and that if they are to be kept in a state of efficiency, a large staff of engineers will always be required for their subsequent maintenance and management. This is a matter which has such an important bearing not only on the future recruitment and organization of the Public Works Department, but also on the successful development of all irrigation works, whether existing now or to be constructed in the future, that we think it right to consider the subject at some length.

299. *Different systems of management.*—Differences in local conditions and other causes have led to the adoption of three distinct systems for the maintenance and management of irrigation works in India. In Madras, where irrigation had from time immemorial been practised on a large scale from numberless tanks which were managed and repaired by the villagers themselves, Government interference in irrigation works was confined to the assessment of the revenue, and to occasional assistance from the Public Works Department in carrying out special repairs or improvements of the works. The necessity for the engineer's interference was exceptional. The villagers concerned kept their

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tanks in order and the revenue officer decided what lands should bear a higher assessment on account of their water advantages. We see no other way, to this day, of controlling the numberless small irrigation works of Madras. It was not unnatural that, when the canal systems were instituted in the deltas, the management which was adopted should have followed the same general lines. It has, however, been found necessary on these canals to entrust the Public Works officer with a large share of the management. He has, it is true, no connection with the work of assessment, or with the internal distribution of the supply which is passed into each water-course. Under the Madras system of fixing a consolidated wet assessment on all lands entitled to irrigation, this is less necessary than elsewhere. But the distribution of the supply between the various branches and distributaries of the canal system is entirely in the hands of the canal officer; he fixes the size of the outlets or sluices at the head of each village water-course, regulates the quantity of water to be passed through each, and decides how long each should run; and he considers all applications for water for lands not previously irrigated, and these are not accepted until he has certified that a supply is available. In all other respects, however, the administration of the canals is in the hands of the district officers, who make all the assessments on crops irrigated on dry lands, deal with all applications for remission, and make necessary alterations in the revenue assessments when new lands are brought under irrigation. The areas actually irrigated are generally measured and recorded in the village accounts, although they do not form the actual basis of assessment. It should be added, however, that the Public Works officer, even in the great deltas, has many other matters to attend to besides the management of the canals. Public buildings and roads are all under his charge, and he serves under two Chief Engineers.

300. In Northern India Government irrigation works on any large scale are a modern institution. The perennial canals carried water to tracts in which irrigation was hitherto unknown, and it followed, naturally, to charge for the water a fixed rate quite distinct from the land revenue assessment. Just as naturally it followed to entrust the distribution of the water and the whole work of assessing the water rate to the engineers, who must in any case be employed to look after the maintenance of the canals. The canal officers form a distinct branch of the local Public Works Department, which is under the control of the Chief Engineer and Secretary to Government for Irrigation; and they are employed exclusively on the construction, management, and development of the canals. The present practice was strongly advocated as long ago as 1867 by Colonel (now General) Sir R. Strachey. R.E., and has been adopted generally on all large irrigation works in the Punjab, in the United Provinces, and in Bengal. It may not have been foreseen at the time, but we have no doubt that the effect of imposing on the irrigation officer the duty of supervising the assessments and the internal distribution of the water-supply has been to bring him into a closer and kindlier touch with the cultivators, and to give him a more detailed knowledge of their wants than would have been possible in Northern India under any other system of management.

301. The practice followed in the Bombay Presidency is intermediate between those in Northern India and Madras. In the Bombay Deccan and in Gujerat the first class irrigation works (on which water rates are generally levied as in Northern India) are managed entirely by the Public Works officers; but the second class works (on which there is usually a wet or consolidated assessment) are, as regards revenue management, under the control of the Civil officers, the Public Works officers, however, undertaking all necessary repairs. The works are less numerous and important than those in Madras; but in two districts, Poona and Khandesh, special irrigation divisions have been formed, the officers in which devote their time exclusively to the irrigation works in the district, and have nothing to do with other public works. The importance of specializing the management of irrigation works is thus recognized. In Sind the canal officers are responsible for all public works in their districts; but except in Karachi the canals are the principal works under their charge, and they devote much attention to them. The charges for irrigation are in the form of a water rate on the area irrigated in each crop; but they are technically land revenue, and

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the assessments and remissions are made by the Civil officers. In this respect the practice differs from that in Northern India, and the canal officers have not the advantage of being brought as closely into touch with the irrigators as would be the case if they were responsible for the work of assessment.

302. We have no desire to propose uniformity in the system of canal management, which has no doubt adapted itself in each province to local conditions and requirements. We regard it of essential importance, however, that the distribution of the supply in all large irrigation works should be closely and continuously controlled by expert irrigation officers, who should be required to keep as strict an account of the disposition of every cubic foot of water entering their canals as they keep of the cash which they draw from the Government treasury. It is only by so doing that they can localize a wasteful expenditure, or prevent an unequal or ineffective distribution of the supply. We have had evidence that in Madras the canal officers have never been able, amid the press of other duties, to devote the time and attention to this subject which its importance demands, and they have not been in the habit of systematically gauging and recording the supplies entering or utilized in the different sections of the canal system. If this be the case, we think that the establishments should be strengthened to the extent necessary to ensure a more complete and effective control over the distribution. This is certain to result in an increase in the efficiency and earnings of the works which will far more than make up for the slight increase in the cost of establishment. The canal officer should also be regularly apprized of all applications for remission of revenue on account of flooding, or of the insufficiency or irregularity of the supply, in time to give him an opportunity of inquiring into the circumstances and taking the necessary measures to prevent their recurrence. The Tungabhadra project, and the new works which we have recommended in the Bombay Deccan, will, when completed, require, even more than the existing works in the Poona Irrigation District, a specialized or expert management. It is not only that supplies which have been stored at an enormous cost will have to be carried over great distances to the tracts to be protected, but also that the distribution will have to be arranged to meet a demand of a very uncertain and fluctuating character, which will have to be carefully studied and fostered by expert officers who will be free to devote a great deal of time and attention to the subject. A strong establishment will always be required for the maintenance and development of works of this class.

303. As regards Northern India and Bengal, we certainly do not recommend any change in the existing system of management. We fully recognize the importance of placing the large and important irrigation works in those provinces under a separate staff of irrigation officers who should not only as engineers be capable of designing, constructing, and maintaining the works, but who should also be trained in revenue management, and devote all their energies to the improvement of the distribution and to the interests of the cultivator. We think that the more closely they are connected with the work of assessment and remissions, and with the settlement of all questions connected with the internal distribution of water within the villages on which a reference is necessary to external authority, the more progressive and sympathetic will be the administration.

304. It is, we are aware, sometimes contended that the engineer should confine himself to his own work, that of construction; and that the distribution of water, the settlement of disputes among irrigators, the assessment of water-rates, and the disposal of claims for remissions, are not properly an engineer's work at all, and would be better carried out by revenue officers and their subordinates, whose training fits them for such questions of administration. We do not dispute that an officer who has been able to pass into the Indian Civil Service, will be able to master the knowledge necessary to direct the distribution of canal water. But, in the first place, his ordinary duties as a district officer leave him little time for such work, which must in practice be delegated to his subordinates; in the second, an officer who may have been able to devote his time and attention to the subject is very likely to be moved to another district where there are no canals,

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and to be succeeded by another who cannot interest himself in the matter; and in the third, the services of the engineer cannot be dispensed with altogether, for he will still be required to inspect frequently all channels, and to attend to the maintenance of the works.

305. If therefore a choice must be made between calling on the district officers to acquire the special knowledge required for the effective management of a large canal, or requiring the canal officers to learn the duties of a revenue officer to the extent that may be necessary for the purposes of canal administration, we should be disposed on these grounds alone, and for the sake of securing continuity in canal management, to prefer the latter alternative. But there is another reason to which we attach even greater importance. The successful manager of a large canal division, the *ideal* irrigation officer, should be something more than either engineer or revenue officer. He is constantly inspecting every part of the system, looking after both his public works subordinates on the canal works and banks, and his revenue establishment in the fields and villages, and hearing all the petitions and complaints of the cultivators. Being thus in daily touch with the canal staff and the cultivators, he is always on the alert to propose improvements in the distribution of water and in all matters of management; his main concern being to get the most he can out of the available supply, not only by localizing waste from Government channels or village water-courses, but also by constant adaptation of the distribution to the requirements of the moment or of the locality. It may well be doubted whether any of the improvements in distribution which have been made in the Northern India canals, would have been proposed if the canal officers had been responsible only for the maintenance of the works. Under a dual control it would have been no one's business to initiate them.

306. *Importance of providing an adequate permanent staff.*—We trust therefore that the great importance of providing an adequate staff of engineers for the maintenance and management of the larger irrigation works may be steadily borne in mind whenever the revision of the establishment scale is under consideration; and that it may not be supposed that temporary establishments only are required, which can be discharged or reduced as works are brought to completion. Canal management is a special subject, and is as important a part of the duties of the Public Works Department as canal construction; and, we may add, success in the design and construction of new works depends to a great extent on the experience gained in the management of those which have been completed.

307. *Service on canals unpopular.*—We think it our duty to call attention to what has been dwelt on by the two members of our Commission who formerly served in the Irrigation branch. They state that when they joined it many years ago it was the most popular branch of the Public Works Department in Northern India, and consequently commanded the services of the most competent engineers. Now this is all changed. Engineers are reluctant to enter the canal service, and anxious to leave it. The consequence of which must be to lower the standard of canal engineers. It would be a misfortune if this branch should become permanently and generally unpopular. It is easier to point out the danger than to suggest the means of preventing it, but it may be sufficient to grant local allowances on a liberal scale to the incumbents of charges which involve much isolation or discomfort. Some system of this kind has already been introduced in Sind and in the Punjab.

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CHAPTER XI.—HYDRAULIC AND AGRICULTURAL EXPERIMENTS.

308. *Necessity for systematic experiments.*—In the course of our investigations we have been struck with the small amount of attention which appears to have been given by the Departments of Agriculture and Public Works to matters connected with the application of water to cultivated crops. At present most of the information which can be had on these points has to be taken from papers published by the Agricultural Bureau in America. It is true that on the larger canals in Northern India careful and reliable records are maintained of the quantities of water passed into each main distributary, and these are compared with the areas actually irrigated. But such observations relate to a large area—that irrigated from the whole distributary—in which many different kinds of crops may be growing simultaneously; and to a period of time which, at its shortest, is the period occupied by a single watering, although the periods of different waterings may also often overlap in such a large area. More detailed, but isolated, observations have no doubt been occasionally taken for some specific purpose, or on the initiation of some zealous individual officers; but they have not been taken systematically or continuously; nor have any great number of observations been scientifically collected in such a way as to render them of much permanent value. The canal officer also has neither the time nor the opportunity, even when he has the training or the inclination, for much specialized observation of this kind.

309. Now that the Government of India has engaged the services of an expert Director-General of Agriculture, and that several provinces have experts as Deputy Directors under the head of the provincial Agricultural Department, we consider it extremely desirable that expert inquiry should be directed to these important matters, which are so intimately connected with the development of irrigation.

310. In the first place, a full record should be kept of the quantities of water, of the number and intervals of waterings, and of the methods and expense of the various processes employed or required in the irrigation of all classes of crops for which water is taken on Government farms. By the study of this information alone much valuable knowledge will be obtainable regarding the most effective and economical mode of distributing and applying water. But more than this is required. Systematic experiments should be made, and carried on continuously for a series of years, with the object of solving the numerous problems which arise in connection with the distribution and application of water to the land.

311. *Distribution of water.*—In illustration of our meaning we may mention that in the cultivation of certain crops, more particularly of rice and sugarcane, there are many indications that the methods ordinarily adopted for distributing water may be exceedingly wasteful. Thus, in the chapter on Bombay, we have referred with approval to experiments as to the comparative quantity of water required for cane when it is supplied at short and regular intervals, instead of, as at present, by heavy flushings at long and irregular intervals. The conclusion at present suggested is that, under the former method, at least equal, if not superior, crops can be grown; and if this fact be incontestably established, it may be possible to exercise a large and valuable economy in the water supplied to existing areas and to set it free for other land urgently in need of it. Experiments like these will be of great value to irrigation officers in framing and correcting their schemes for the permanent distribution of canal water.

312. Again, the demand on the supplies passed down the Sone Canals in Bengal depends entirely upon the requirements at a critical period in the autumn, known as the *hathia*. The period is at present estimated at about a fortnight. The quantities of water required from the canal depend on the rainfall during or shortly preceding this period. And when the fall is seriously deficient, as in the year 1899-1900, the water passing down the canal is found to be barely

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sufficient for 290,000 acres of rice land. But the canal is capable of discharging for a much longer period the quantity of water required for the autumn flushing, and it is not unlikely that the flushings taken during the period, as now limited, are heavier than necessary. An investigation as to the exact quantities of water required at this time, and the possibility of lengthening the period of distribution, might result in demonstrating that the volume of water required for each acre is less than is generally supposed; or that the periods during which water is given may be made shorter; or that the critical period, during which it must be given in order to save the crop, is longer than is now assumed. The conclusive establishment of any one of these propositions will render possible the extension of irrigation in this tract by many thousand acres, to the great advantage alike of the revenues of the canal, and of the people who are urgent in their demand for the water.

313. Similarly, on the Cauvery system in Madras, heavy flushings are taken by those cultivators who can get the first pull at the canal water, to the detriment of their neighbours lower down. It is worth inquiring whether they would suffer by some curtailment, and a safe conclusion can only be reached by careful experiment. Again, on the Periyar Canal there is the question of the possibility of successfully raising two crops within the nine months during which an annual supply is now available. This might well be made the subject of special experiment.

314. The seepage of water in long water-courses is another question which could be studied by the Agricultural Department with great advantage. Every drop of water taken on the Government farms or experimental plots, ought to be carefully measured and accounted for; and the quantities of water required for the efficient irrigation of a given crop, when conducted from a given point by means of unpuddled or puddled channels, should be accurately measured and contrasted.

315. *Introduction of new crops.*—As an example of an experiment to test the adaptability of irrigation to conditions which at first seem unpromising, we may mention our suggestion that rice should be cultivated experimentally by the Agricultural Department in various soils, including the *mar*, or black cotton soil, under the Betwa Canal. This experiment will serve the double purpose of demonstrating whether for rice cultivation the water could be profitably utilized for the irrigation of soil which is at present regarded as refractory, and whether any use can be made of the large volumes of unstored water which can be passed down the canal during the *kharif* season; or whether the usefulness of the canal must be almost wholly measured, as at present, by the supplies which it can give in the dry or *rabi* season, and for which dependence must be placed wholly on storage.

316. *Application of water to the soil.*—Under this head would fall experiments in the modes of leading the water over the fields, and of preparing the land to receive it. On this subject some ideas were placed before us by Mr. Kashirao Jadhava, an officer of the Baroda State, who has been experimenting on a system of furrow-irrigation for the watering of crops in black soil. This is no doubt a question of considerable importance on which experiments on similar lines may be made with advantage.

317. For ascertaining the minimum quantities of water with which any crop can be successfully irrigated, as well as for the determination of the comparative cost of lift and flow irrigation, crops should be freely cultivated on the experimental farms by means of well-irrigation, and a careful record kept of all details with reference to the quantities of water used, the time in which it was delivered, the number and frequency of waterings for the different crops, the kind and quantity of manure, the various crops which can be raised with the best chances of profit, and so forth.

318. *Application of water to certain crops.*—Lastly, experiments should be made as to the value of irrigation for crops which are usually grown

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without its aid, as for instance cotton. In the case of this crop some extended inquiry might be made with advantage into the question whether the quality and yield of existing varieties could not be improved; or whether exotic varieties, such as Egyptian cotton, or hybrids between exotic and indigenous varieties, could not be profitably grown by means of irrigation. The experiments in hybridization of cotton, which are now being conducted on the Surat farm under the direction of Mr. Mollison and the Provincial Department of Agriculture, will serve as a start for some of these investigations; and promising ground for them can probably be found in parts of the Punjab and United Provinces where the areas under irrigated cotton are increasing.

319. *Discovery of a rust-proof wheat.*—Inquiries, which have already made some progress, with the object of discovering a variety of wheat which, though irrigated, will be proof against rust, should be prosecuted with unremitting energy.

320. *Irrigation and rainfall.*—Lastly, on all experimental irrigation plots, the quantities of water taken for various crops, both in years of abundant and of short rainfall, and the effect of irrigation on the yield of the crops, in the different classes of years, should be carefully recorded.

321. *Plan of operations.*—All classes of experiment should be continuous and maintained for a series of years. To make them effective it will be necessary that the plans of experiment should be drawn up in consultation by the experts of the Agricultural and Public Works Departments. It will also probably be advisable to follow the example recently set in the Central Provinces, and provide a considerable number of farms or experimental plots in different parts of each province; and particularly on the lands irrigated from the larger Government works, in the management of which the questions to be investigated will principally arise. These farms or plots ought to be worked by the Agricultural Department. In addition, endeavours may also be made to induce intelligent landowners and cultivators to work some of their lands upon lines laid down for them by the experts. The results so obtained will in some instances prove valuable, both in themselves and as checks upon the results obtained on the Government farms and plots. But, for some time to come, the chief reliance will have to be placed on results obtained from the experiments conducted by Government agency.

322. In conclusion, we desire to express the emphatic opinion that if experimental research of the kind which we propose is to be of real use, it must be under the supervision, in every case, of a trained expert provincial officer under the general guidance of the Director-General of Agriculture. The officer in question must have the assistance also of thoroughly well-trained, skilful, and trustworthy subordinates. Such subordinates are not always easy to obtain; and until they are found, it will be desirable to restrict the experiments to select localities, and to extend them gradually as men become available.

323. The execution of an effective scheme of experiment will require a not inconsiderable outlay, and some time must elapse before full results are reaped from the proposed inquiries. But we entertain no doubt that in the end the outlay will be more than recouped by extensions of irrigation, economy in the use of water, and a general improvement in the irrigation revenue.

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CHAPTER XII.—FAMINE RELIEF WORKS AND PROGRAMMES.

SECTION I.—WORKS CARRIED OUT DURING THE RECENT FAMINE.

324. *Expenditure on various classes of works.*—The following table gives an approximate idea of the distribution of the expenditure, exclusive of special establishment charges, incurred on relief works in those provinces of British India in which famine labour was employed on any considerable scale during the famine of 1899-1900. The figures are not complete, as they do not include expenditure incurred subsequently to that for which we have obtained the details; and we are unable to vouch for the correctness of the classification in all cases, especially in the case of village tanks and irrigation works.

Class of work.	EXPENDITURE IN LAKHS OF RUPEES.						
	BOMBAY.		Punjab.	Central Provinces.	Berar.	Ajmer-Merwara.	TOTAL.
	Gujerat.	Deccan.					
Roads and road-metalling	8·00	128·07	4·42	112·84	54·75	18·00	326·08
Railways . . .	3·00	2·47	1·86	9·62	14·50	...	31·45
Village tanks . .	50·00	6·45	27·51	14·07	9·75	...	107·78
Irrigation works . .	25·00	77·10	5·97	23·23	...	11·00	142·30
Miscellaneous . .	...	0·02	0·45	5·89	...	...	6·36
Total .	86·00	214·11	40·21	165·65	79·00	29·00	613·97

325. *Roads and collection of metal.*—It will be seen that, except in the Punjab and Gujerat, a very high proportion of the total expenditure was incurred on roads and road-metalling. We fear that, generally speaking, the utility of this work was not great, except where the new roads have been or are likely to be completed, or where the stores of metalling provided are likely to be utilized within a reasonable period. In Bombay the need for more roads is not urgent. The railways are already fairly provided with feeders, and the District Boards have not the funds for the effective maintenance of more. There are, however, parts of the country, for instance Khandesh, where additional roads are likely to be of use. But the relief work done on those which were taken up has not left them in an efficient condition. To make them of value in the rainy season a great deal of expensive bridge and cross-drainage work will have to be done, for which probably the funds of the District Board are insufficient. The same remarks probably apply to the Central Provinces, where over a crore of rupees had been spent on this class of work during the famine of 1896-97. But in all provinces the greater part of the expenditure recorded under this head appears to have been incurred in the collection of road-metalling rather than in the construction of new roads. This expenditure was, it is to be feared, even less useful than that on the construction of new roads. In many instances the traffic did not really require a metalled road. The expense of spreading the metal is generally more than the District Boards could undertake, and the maintenance of the road, which particularly in such a country as Gujerat would be very costly, is far beyond their resources.

326. *Railways.*—The total expenditure on railway samounted to nearly 31½ lakhs, to which may be added 20 lakhs which we are informed was spent on railway works in the Rajputana States. The utility of this work must depend on the prospect of the railways being completed within a reasonable time. On this point we have taken no evidence, but the Government of India

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will be able to form an opinion of the extent to which the work done is likely to be utilized, and of its actual value. When the construction of a railway has been actually decided on, relief labour may be very usefully employed on it, but it is to be feared that railways will never afford employment to more than a very small proportion of the numbers requiring relief during severe or widespread famine.

327. *Village tanks.*—The expenditure on village tanks was very large, particularly in the Punjab and in Gujerat. We refer elsewhere (II, 74) to the Punjab works of this class, which, like the great tank at Broach, or the large tanks which formed one of the principal forms of relief work in Bihar in the famine of 1896-97, appear to have been undertaken more on account of their suitability as a means of employing relief labour than in consideration of their actual utility, which is infinitesimally small when compared with the expenditure incurred on them. The principal value of such works is in conserving a water-supply for cattle, but in the Central Provinces appreciable use can be made of them for irrigation purposes. This must be true also of many of the tanks in Gujerat, for it is always difficult to draw the line between village tanks used only for drinking purposes and for watering cattle, and those which have some value as a means of irrigation. We have, however, pointed out (II, 139) that a much smaller share of the expenditure in Gujerat appears to have been devoted to irrigation tanks than might have been possible.

328. *Irrigation works.*—Of the irrigation works actually carried out, one in the Punjab and many in the Central Provinces are likely to prove useful. The same may be said of some of the works in the Ahmadnagar and Sholapur districts; but the utility of those in the former will depend on the early construction of the great storage work on the Pravara river (Maladevi) which we have recommended. The majority of the Bombay irrigation relief works are, however, tanks without any storage supply situated in tracts of light and precarious rainfall; and although in years of ordinary rainfall they cannot fail to be useful, their utility as real famine protective works is more doubtful, even if they are eventually completed. Some are too large to make it worth while to incur the heavy expenditure required for completion; and even if another famine occurs at no distant interval, it is doubted whether any considerable proportion of the work will ever be carried out by relief labour.

329. *General utility of the works.*—On the whole, then, it is impossible to say that the utility of the works executed during the recent famine is great. The principal reasons for failure to execute useful works are: first, that, in the absence of fully considered and detailed programmes of work, it was impossible to fix on works, which would be at once useful and properly adapted to the employment of relief labour; and, secondly, that conditions do not admit of providing works of utility for more than a limited section of the population.

330. *Completion of unfinished works.*—Our recommendations relating to the completion or definite abandonment of uncompleted works will be found in our Provincial Chapters. These recommendations are confined to works of irrigation. We believe that a special report in respect of railway works has already been submitted to Government, and we did not regard it as within our province to inquire particularly into the merits of other works. We think, however, that the case of all other uncompleted famine works, the usefulness of which depends on their being completed, should be carefully examined by the Local Governments; and that no delay should be allowed to occur in the completion of those which can, at moderate expense, be made useful to the country. In the case of partially made roads, where the resources of District Boards are sufficient for the purpose, the Boards should be urged to undertake their completion; and, where the utility of any road would justify such a course, the Local Government might consider the advisability of making some grant-in-aid to the Board.

331. And here we think it desirable to observe that, in deciding whether it is advisable to complete any revenue-earning work which has been begun by relief labour, the previous expenditure on such labour should be left altogether

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out of account. For that expenditure must be regarded as having been inevitable, apart altogether from considerations of utility, and as having been incurred on whatever work was deemed at the time to have been most likely to prove useful. Thus, if the total capital cost of any work at ordinary rates be ten lakhs, and five lakhs' worth of work had been done by relief labour, and supposing that it were considered worth while for protective purposes to complete the work if it paid 2 per cent. on its capital cost, then, roughly speaking, a net return of Rs. 10,000, amounting to 2 per cent. on five lakhs, would justify the completion of the work. We do not, by this recommendation, mean to run counter to the principle laid down by the Famine Commission of 1898 in paragraph 411 of its Report, where it is said that, in reckoning how far a work pays its capital cost, the full expenditure on the work at ordinary rates should be taken into account. The principle here suggested is to serve as the criterion of the desirability of completing the work, not as a measure of its remunerativeness.

Section II.—EXISTING PROGRAMMES.

332. *Quantity and utility of proposed works.*—We have examined the programmes in every province which we have visited. We generally find them complete as to the provision of sufficient quantities of work for such proportion of the population as is likely to be affected by severe famine. The works provided in existing programmes are, however, frequently of doubtful utility. In Bombay and Madras they are practically confined to the construction, improvement, and repair of roads, and the accumulation of road-metal, with a certain number of dams and tanks of problematical value for irrigation purposes In the Punjab and in Bihar the principal works are the large village tanks to which we have already referred. In the Central Provinces about 40 per cent. of the proposed works are designed for irrigation, 30 per cent. are railways, less than 30 per cent. consist of roads and road-metalling, and about 10 per cent. are village tanks. The preponderance of irrigation works and the small proportion of road-works in the programme are satisfactory when considered with reference to the actual distribution of expenditure on relief works in the famines of 1896-97 and 1899-1900. It is claimed that most of the works in this programme are of a useful character, but the degree of utility likely to be attained must for the present be regarded as uncertain, as many of the works have been hurriedly selected.

333. The fact that so many of the works included in the programmes of all provinces are of questionable or very small utility, is not the fault of those who have framed them. There is, in most tracts, a limit to the number of useful works which can be devised; and the difficulties in selecting them are everywhere formidable. In the first place, it is not always easy to determine what kind of work is likely to prove the most useful in any locality. For instance, in deciding on a work of irrigation, the soil, agricultural conditions, and the rainfall of the tract, will have to be carefully considered, with many other factors. In the next place, the selection of works which are not only useful, but also well-adapted for the employment and organization of famine labour, is exceedingly difficult. In most places there are few obviously useful large works which, even if they can be partly executed by famine labour, will not require for their completion heavy expenditure on skilled labour, material, and land compensation. And it is by no means easy to form a judgment beforehand as to whether the expenditure on completion will be justified or not. In the case of local works such as metalled roads, however useful they may be, there is always the doubt whether their subsequent upkeep may not prove too heavy a burden on the locality.

334. *Inadequate provision of village works.*—Another defect to which we have to draw attention is the small provision for village works in the programmes of all provinces except Bengal and the United Provinces, and the nature of the works proposed both in those provinces and elsewhere. We are somewhat surprised at the small number of village works in the programmes of the Central Provinces; and, in particular, at the omission of field embankments, some

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of which were made with considerable success during the last famine. But here, as elsewhere, the programme of village works other than those to be constructed by the agency of the Public Works Department, is very scanty and incomplete. It may be said that, almost without exception, the only kind of village work proposed is the enlargement of the existing village tanks or the construction of a new tank for watering cattle, etc. It is not clear whether it is intended that these works shall be carried out by departmental or civil agency; but they do not appear to be works of the kind contemplated in paragraph 12 of the Report of the Famine Commission of 1901, the construction of which may be entrusted to local and gratuitous unofficial agency. They have been brought on the programmes not so much on account of their intrinsic merit as works for promoting the well-being of the village community or affording it any real protection in seasons of drought, as because they are works on which village labour can be conveniently employed. We do not say that all these works are of no utility. In some cases they may be well worth constructing; but we fear that most of them have been included in the programmes more for the sake of completing them by entering as many centres of employment as possible, than on account of the intrinsic utility of the works themselves.

Section III.—PREPARATION OF PROGRAMMES.

335. *Relative importance of public and village works.*—We have now to discuss the mode in which programmes should "be prepared, revised, and maintained" with the object of "ensuring the application of relief labour, as far as possible, to works which have a real protective value," and of indicating how, in every province, the "arrangements for meeting famine, and for the employment of local labour, may be in so advanced a state that operations may commence as part of a continuous programme, without the dissipation of force or the delays resulting from hastily prepared and often imperfect schemes." The Famine Commission of 1901 referred by anticipation to the duty which these instructions have imposed on us, when they remarked that they were not required by their instructions to consider in all its aspects the important question of the place to be assigned to public and village works, respectively, in the scheme of famine relief, inasmuch as the utility of the works constructed during the recent famine had been reserved for separate inquiry.

336. In dealing with this question we must refer at the outset to two considerations, each of which affects the proposals to be made for the preparation and maintenance of programmes of relief works. The first of these is the fact that we have already recommended a very extensive programme of protective irrigation works, to be constructed as rapidly as may be practicable in many of the tracts that are most liable to famine; and also expenditure on a considerable scale in all exposed districts, to be incurred in encouraging and stimulating the construction of private irrigation works. The second consideration is the fact that the Famine Commission of 1901 have somewhat strenuously advocated that greater reliance be placed in future on village works as a means of employing relief labour than has been the practice in recent famines. We have no hesitation in endorsing generally the remarks on this subject which are contained in paragraphs 54 to 60 of their Report; but we observe that, although the Commission were in favour of employing relief labour more extensively than formerly on village works, they realized as clearly as the Commission of 1898 that reliance could not be placed solely on village works. They remarked:—

> But, while in favour of village works as the backbone of the relief system in a district where a sufficient number of them can be found, we are not sure that there are many such districts; and we consider that, even in such districts, it will always be necessary to have some suitable large public works in addition, not only as an alternative, but also as a safeguard.

337. We fully recognize the great value of village works as a means of affording employment for relief labourers of certain classes or in certain circumstances; but we must at the same time emphatically express the conviction which was shared by the Commissions of 1898 and 1901 that in any severe, extensive, or long continued famine, reliance cannot be placed on village works alone; and that in most districts public works must really form the backbone of relief

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operations. It is unnecessary, however, to consider the relative merits of the two systems, for the claims of each to adoption are not antagonistic or exclusive. There is room for both, and the one is a useful and necessary supplement to the other. The only real question for consideration is the proportion which one may most conveniently bear to the other. This must be regulated according to circumstances; but the ruling circumstances upon which, as pointed out by the Commission of 1901, the final decision will largely depend, are "the utility or otherwise of the public works, and the sufficiency or otherwise of programmes for village works in particular districts." We would add, however, in respect of village works, that regard should be paid not only to the numbers entered in the programmes, but also to their utility, and especially to their value for protective purposes. Our view is that for both classes of works there should be definite standards by which to appraise their utility, and that future programmes of relief works should be prepared with reference to these standards.

338. *Employment of relief labour on proposed irrigation works.*—As regards public works, the most obviously useful are those which have been formally sanctioned, and are in actual progress at the time that famine is declared; provided, of course, that they are located sufficiently near to the distressed area and offer work of a kind which can be carried out by famine labour. These conditions are most likely to be fulfilled on the large protective works, the construction of which has been recommended in Chapter IV of this report. If that programme is accepted and worked up to, it may fairly be hoped that in the event of a recurrence of famine within the next fifteen or twenty years, there will be a number of works in actual progress in many different districts which will be capable of affording employment to all the labourers who can be attracted to them. The real difficulty, even in seasons of famine, will not be to provide enough work for the available labour, but to find enough labour for the work to be done.

339. We desire, however, to make an important recommendation in regard to works of this kind. Although they will afford an invaluable means of employment for effective labour, we deprecate any attempt being made to utilize them for the employment of any labour that is not moderately effective. Both the quality and the rate of progress on such works is certain to be impeded if the work is carried out under what are known as famine conditions, and is crowded with three times as many labourers as can be usefully employed, from none of whom can more than a small fixed task be taken. We think that, even after famine is declared, an attempt should be made to carry out the work by the usual departmental method, that is by petty contract, for as long as possible; in the certainty that it will afford attractive employment to large numbers of the able-bodied labourers who would otherwise be driven to the ordinary famine relief works. If it is found that something more than this is necessary in order to draw to the works all the fairly effective labour that might be employed on them, and for which useful employment in some form must be provided, we would recommend that certain sections of the work be reserved for relief labour to be drawn from the villages within a certain radius; and that in these sections the system of family piece-work, without any maximum limit of task or wage, should be introduced. We are aware that the system of piece-work, without any maximum limit to task or wage, although noticed with guarded approval by the Famine Commission of 1898 (*vide* paragraphs 212 and 461 of their Report), finds no place in the 'New Code' system advocated in paragraph 80 of the Report of the Commission of 1901, in which a maximum limit to daily earnings is contemplated. But the objection to an unlimited wage has little force in the case of revenue-earning and protective works of this class, which it is in the public interest to complete in a thoroughly efficient manner as quickly as possible. Government will get full value for all the money paid; and if the labourers are able to earn more than the normal famine maximum wage, some of the difference, at any rate, will go to the support of dependants and others who must otherwise be provided for by Government. The problem of finding suitable village works for those who cannot attend the public works will be much simplified; and high wages, if well-earned, will give encouragement to the people and, when well-earned, will prevent much of the demoralization

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which is almost inevitable on the ordinary famine relief works. On these works good work and rapid progress will be the main consideration, to which their usefulness, as affording a means of employment to distressed labour, will be subsidiary. These arguments may be held to apply to other public works in actual progress at the time that famine is imminent; but with less force if they are not of a protective character, or if the quantity of work which they can supply is much below the probable demand for employment.

340. *Works sanctioned on their merits.*—Next in order of utility are those works for which regular estimates have been sanctioned on their merits by competent authority, for execution as soon as funds may be available, but on which work has not been actually commenced. In the case of a protective irrigation work, the sanctioning authority would be the Government of India or the Secretary of State, as the case may be. If the estimate is for a provincial public work, the sanctioning authority will be the Local Government. In both cases the execution of the works according to carefully prepared plans and estimates, will have been decided on, irrespective of the demand for employment for relief labour; and it may be assumed that, if the work is begun but not completed by famine labour, it will certainly be completed within a reasonable time after the closure of the relief works. We see no reason why piece-work, with no restriction as to maximum task or wage, should not be adopted also on works of this kind; but the case for it here is not so strong as on works actually in progress at the time famine is declared. It should be left to the Local Government or Famine Commissioner to decide in all these cases whether the New Code system or unlimited piece-work should be adopted.

341. *Useful works reserved for famine.*—The next class will be public works for which detailed estimates have been sanctioned by competent authority, as useful works to be executed in time of famine, and which are likely to be completed by relief labour; or the completion of which, otherwise than by relief labour, will not involve an expenditure that there may be any difficulty in providing for. Estimates for new roads will fall under this class, if the roads can be completed during the famine, or at a moderate cost after its close, to such an extent as to be utilized as a communication. Estimates for collecting metal for use on existing metalled roads, or for any other purpose on which it can be utilized within a reasonable time, will also be included; but if the metal is to be collected for laying on an unmetalled road which is never likely to be metalled, or which the district could not afford to maintain as a metalled road, the estimate will not fall under this head.

342. *Useful village works.*—The next head will include all sanctioned estimates for village works which may be certified by competent authority as having a real agricultural or protective value, such as field terraces or embankments, the clearance or improvement of existing irrigation tanks, and the construction of new tanks where suitable sites can be found.

343. *Order of eligibility.*—Works in which these conditions are not fulfilled will come next; and we may then place all possible kinds of relief work in the following order of eligibility—an order in which eligibility will depend not merely on the actual usefulness of the work when completed, but also on the prospect of its ever being completed. No relief labour can be more useless than that expended on a work which, however useful, if eventually completed, will probably remain as a famine folly, incomplete for ever.

(*a*) Works of the kind referred to in paragraph 338.
(*b*) Do. do. do. 340.
(*c*) Do. do. do. 341.
(*d*) Do. do. do. 342.
(*e*) Proposed works of class (*c*) or (*d*) for which detailed estimates have not been sanctioned.
(*f*) Village works of little or no protective value, but on which relief labour may be employed, if necessary, under departmental agency.

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(*g*) All proposed public works, whether protective or not, which, although not altogether destitute of utility if completed, cannot possibly be completed by famine labour, or which cannot be rendered of any use without committing Government to very heavy expenditure in addition to whatever may be spent on famine labour.

344. *Sanctioned and emergency programmes.*—The district programmes should then consist of two parts: Part A would comprise all works falling under heads (*a*) to (*d*) and would be a *sanctioned* programme; and Part B, comprising all other proposed works, would be an *emergency* programme. All works included in Part A would be regularly sanctioned works of utility, which would certainly be completed either during or soon after the famine. Part B would comprise unsanctioned works of doubtful utility, or the utility of which depended on their completion, which would also be doubtful. Relief labour would not ordinarily be employed on works in Part B as long as employment could be afforded on works in Part A; but works under head (*e*) or (*g*) in Part B would, from time to time, be transferred to Part A, as soon as the regular sanction of competent authority had been obtained for them.

345. *Special establishment required for preparation of programmes.*—There is another distinction between these two parts of a district programme of works to be constructed by departmental agency which will explain our reason for proposing to maintain them separately. Part B can be compiled, as at present, without much difficulty by the ordinary local establishment; but the compilation of Part A will often involve heavy expenditure on the maintenance of a special establishment, whose duty it will be to prepare for sanction as many detailed estimates as possible of all works falling under heads (*a*) to (*d*). There can be little doubt that the utility of the work carried out by relief labour in recent famines would have been very much greater than it was, if the labour had been employed on works of which the detailed estimates had all been considered and sanctioned beforehand. The point on which we wish to insist is that time and money are required for the preparation of an effective programme of relief works, such as we propose for Part A. This, in many cases, cannot be framed without a special expert agency for the preparation of detailed projects of public works, and for the selection of sites, preparation of standard designs, and detailed estimates for village works of the kind referred to in paragraph 342. The cost of such an agency may seem unnecessarily high when famine is not impending; but we observe that, during the famine of 1899-1900, no less than 300 lakhs were spent in the Bombay Presidency on relief labour, and money will not be thrown away which is spent on adequate preparations for expenditure on such a scale as this.

346. In the case of State irrigation works, such a special establishment will be at hand, if our recommendations regarding the construction of new works are accepted; and we have only to point out here that it will not suffice merely to keep investigation of such works slightly ahead of construction. Thus, supposing that it is considered advisable that not more than two new projects should be in actual progress simultaneously in the Bombay Deccan, it will not be sufficient to investigate only one other scheme, so that its construction may be taken up as one or other of the two works in progress approaches completion. This is not what we contemplate. We hope indeed that it may be possible to start one or two large protective works as soon as detailed estimates have been sanctioned. But we desire that every possible project for the utilization of the rainfall of the Ghats on the plains of the Deccan should also be investigated, if not simultaneously at any rate in rapid succession; and that each should be submitted, for the provisional or administrative sanction, on its merits, of the authority competent to sanction, without reference to the date on which it may be proposed, in the absence of famine, to commence work. There are many advantages in thus completing as soon as possible the investigation of the whole scheme of protection; but not the least of these is that it will be possible to employ relief labour in any part of the tract concerned, with a certainty that the work on which it will be employed will be ultimately completed. Similarly in the Central Provinces, it will probably not be expedient, at any rate for the present, to undertake the actual construction simultaneously of more than five or six of the works which

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we have proposed; but there are hundreds of such works to be carried out, each of which will involve a good deal of investigation. We should like to see detailed estimates for all of these completed as soon as possible and submitted for the orders of the authority who could, in the ordinary course, have power to sanction them. That authority would consider them on their merits and would pass orders, either rejecting them finally as of doubtful utility or too costly, or sanctioning them as works to be proceeded with at once, or as soon as funds could be conveniently provided, or whenever work was required for the employment of relief labour. In the first case, the work would remain in Part B, or the emergency programme, under the head (*g*); in the others, it would be at once placed in Part A, under the head (*a*), (*b*), or (*c*), as the case might be.

347. As regards other public works and village works of the kind referred to in paragraph 342, the work of preparation may, in some cases, be entrusted to the special establishment employed in connection with the protective projects, and in others be carried out by the ordinary Public Works establishment of the district, which should, however, be strengthened when necessary for the purpose. For the village works something more than this may often be required. The Public Works Department may often be able to make useful suggestions as to sites, etc., but its main duty will be to prepare standard plans, specifications, and detailed estimates of cost, for such works as may be proposed or approved by the Civil officers. It may, therefore, sometimes be advisable to appoint special revenue officers, who could prospect for works of this class, and do other work in connection with the encouragement of private works of agricultural improvement by means of *takavi* loans or of the grants-in-aid which we have recommended elsewhere.

348. *Sanctioned programme to be limited to actual requirements.*—But, although the work of preparing Part A of the programmes may be costly, it will be possible to limit its extent. However questionable may be the utility of some of the works entered in the existing programmes, we have, as already stated, generally found them complete as to the provision of sufficient quantities of work for the numbers likely to require employment even in a severe famine. In some provinces the provision made is actually in excess of requirements, *e.g.*, in Madras where 20 per cent. of the population has been provided for in every district, and in the United Provinces where provision has been made for 30 per cent. In some programmes provision has been made for districts of which the liability to famine is extremely remote. It seems hardly necessary to make detailed and elaborate provision, or to prepare at considerable cost such fully thought-out programmes as we propose, for districts which have escaped scot-free from famine during the last forty years; or for a much greater proportion of the population of other districts than that for which it has been necessary to provide employment during the recent severe famines. It is for this reason that we propose to divide the programmes into two parts. In all districts, works which fulfil the required conditions will be entered in Part A, as soon as they have been formally sanctioned by competent authority; and, in all, the greater the number of such works that can be so included the better. But we propose that no special efforts, involving considerable expenditure, should be made to include in that Part a greater number of works than will be required to provide employment for such a proportion of the population as is likely, so far as can be judged by past experience, to come on to the works. It may be urged that, if this principle be followed, there may be some danger of famine overtaking unprepared districtswhich have been regarded as immune, as has actually happened recently in the case of Gujerat. But for the few districts of that kind which remain, and for possible but remote contingencies in other districts, programmes prepared as at present, which correspond with Part B of our programmes, should suffice. It is, indeed, exceedingly doubtful whether, at any moderate cost or with much ultimate utility, thoroughly efficient programmes could be prepared for anybut what we may call true famine districts. These should be first taken up in order of urgency, and when the wants of that proportion of their population which is certain to require relief are fully supplied, the expediency of taking special measures for perfecting the programmes of other districts can be considered. Our point is that establishment, time, and money,

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are required for the preparation of really effective programmes of relief works; and that it is therefore necessary to discriminate between requirements which are obvious or immediate, and those which are improbable or remote.

349. *Programme of village works.*—The programmes which we have considered are those of the Public Works Department, for works which will in the main be carried out by departmental agency. It is possible that, in the actual stress of famine, some of the village works included in them may more conveniently be entrusted to Civil agency, as was the case in Bengal and other provinces in recent famines. But, as we have already pointed out, they do not include village works with which the Public Works Department will certainly have no concern, and which can only be carried out by Civil or Local unofficial agency. We have proposed to include some works of this kind under head (*d*) of future programmes, but they will only be works in regard to which some advice or assistance from the Public Works officers may be required. If the policy of finding employment for relief labourers in the neighbourhood of their homes is to be developed to the utmost, there must be provided many small village works, whether classed as aided or unaided, in addition to those which have been actually entered in the present programmes. We do not think it necessary or convenient to enter works of this kind, with which the department will have no concern, in the departmental programmes; but the importance of maintaining programmes of some kind for such works should not be overlooked. It may be necessary, as we have already suggested, to strengthen temporarily the district staff, until an extensive programme of useful village works has been obtained; or it may be possible to devise arrangements under which such a programme may be forthcoming on the first warnings of famine. We invite attention to the subject, but are unable to suggest the most suitable procedure, which will probably depend very much on local conditions.

350. *Sanctioned programme to be first utilized.*—If our ideal programme were completed, distressed labour would be first employed, after famine had been declared, on works in Part A, falling under the heads (*a*) to (*d*). The order of utility would be indicated by these letters; although in practice it would be impossible to follow it in opening works, as regard would have to be paid to many other considerations. But all works entered in this part would be works of utility, although of a varying degree, and any one might be undertaken with some confidence that it would not be left unfinished. If requirements could not be met from Part A, works included in Part B would be opened, preference being given to those under heads (*e*) and (*f*), works under head (*g*) being opened only as a last resource. We are inclined to think that works of this kind should never be opened without the express sanction of the Local Government, if their completion, otherwise than by relief labour, will involve a charge of more than five lakhs or some other suitable limit. But if programmes are prepared as we propose, and continuous efforts are made to complete detailed estimates for protective works in the districts most exposed to famine, and to place them on the list of sanctioned projects, we hope that it may never be necessary to employ labour on large projects which may never be sanctioned, and the details and cost of which have not been worked out.

351. *Utility the main consideration.*—With programmes systematically maintained, as proposed, there should be little difficulty in determining the proportion which village should bear to public works. The principal consideration, which will justify a preponderance of the former in any locality, is their superior utility. In many cases this will be found incontestable. There are, indeed, many parts of the country in which the only work which will give any measure of protection, is the field embankment, or small village tank which can be used for irrigation. In others, there is nothing better than the repair of tanks, even by means of silt clearance, which, although extremely expensive in relation to the results obtained, is admirably adapted to the employment of relief labour, and is thoroughly effective as far as it goes. Where no other form of comparably useful work exists, we should not hesitate to recommend almost exclusive reliance upon such village works as these. There is no reason to suppose that the difficulties of supervision will prove altogether insurmountable, and it is

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better to tolerate some laxity of supervision, than to acquiesce in the performance of useless work.

352. Lastly, we think that, in considering the prospective utility of any work, regard should not be had solely to public utility; and that, in preference to works of doubtful or of no public utility, works likely to be useful to proprietors or cultivators of land should be freely undertaken. In many cases means may be contrived to obtain, sooner or later, some return to the State for the outlay thus undertaken. But even where this is impossible, it will be better to do work which results in improvement and protection of the land, than work which has little or no beneficial result beyond the provision of a labour test for able-bodied persons in need of relief.

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CHAPTER XIII.—SUMMARY AND CONCLUSION.

353. *Introductory.*—In the preceding chapters we have endeavoured to describe the present state and the extent of irrigation in India, its use and value in increasing the produce of the land and in affording protection against famine, the scope that still remains for its future expansion, both by public and private works, and the limitations to such expansion which are imposed by physical and financial considerations. We have considered the financial results which have been attained on all existing State irrigation works; and we have estimated the financial burden which our programme for the construction of new works may impose upon the State. In the Provincial Chapters (Part II) these matters are again considered in greater detail for each of the Provinces and Native States which were visited by us, and some particulars are given of the character and utility of the works on which relief labour has been employed during recent famines, and of those which have been entered in the latest programmes of famine relief works. In the remaining chapters we have discussed, in their relation to our main proposals for the extension of public and private irrigation works, several subsidiary questions, such as the possibility of utilizing artesian sources of supply; the classification and financing of State irrigation works; the provision of the additional establishment required for their construction and subsequent maintenance; the methods of charging for canal water; the value of agricultural experiments in connection with practical irrigation; and the future preparation and maintenance of programmes of famine relief works. We now propose to summarize our principal recommendations on these points, and to make a few additional remarks and suggestions which have been reserved for this concluding portion of our report. We shall, in the first place, refer to our proposals for works of a certain magnitude, which, for our purpose, may be roughly indicated by the condition that the cost is not likely to be less than 25 lakhs.

LARGE IRRIGATION WORKS.

354. *Punjab.*—In the Punjab we found a complete scheme known as the Lower Bari Doab, which had been fully worked out and submitted to the Government of India for sanction. We proposed, with great reluctance, the postponement of this important scheme until an alternative scheme for irrigating the same tract by means of a canal from the Chenab, to be carried across the valley of the Ravi, could be further examined. If this bold alternative scheme be feasible, it will be much more expensive than that hitherto proposed, but its protective value will be much greater, and it will probably be no less remunerative. If carried out, it will be second in importance to no other irrigation work in the Province. We have heard with satisfaction that the reconnaissance, which has been lately undertaken, indicates that this grand project, which will involve the diversion of part of the cold-weather supply of the Jhelum river into the Chenab, and possibly also the conversion of the Wular Lake into a reservoir for the storage of the head waters of the Jhelum, is regarded as feasible; although the probable cost has yet to be estimated. We have recommended that, if the original scheme be adopted, a supplementary project should be prepared for the immediate construction of one or more additional weirs across the Sutlej, and for linking up all the inundation canals on both banks, or in British and Bahawalpur territory, and connecting them with new main canals to take off from above the works proposed. If the alternative scheme be adopted, this supplementary project will not be urgently or immediately necessary, as there will be no interference with existing conditions on the Sutlej river; its execution at some future time should, however, be contemplated, as it is only by these means that the available supplies of the Sutlej can ever be fully utilized. A third large project is the great Sind-Sagar scheme, in respect of which we have recommended, as a preliminary and tentative measure, the construction of a small canal, with its head at or near Bhakkar, for the irrigation of that portion of the Doab which can be commanded by such a work.

355. *Sind.*—We have recommended a continuance of the present policy of extending and developing to the utmost the existing inundation canals in Sind,

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and we understand that, by this means, the irrigated area may be increased by at least 400,000 acres. We are unable to recommend the construction of a permanent weir across the Indus as long as so much can be done for the extension of irrigation by less heroic, and less difficult and costly measures. But the eventual construction of such a work should be contemplated; the data required for the preparation of the project should be collected; and in preparing all schemes for new works the possibility of a weir being constructed at some future time should be kept in mind.

356. *Gujerat.*—In Gujerat we have recommended that an attempt be made to find suitable sites for storage works on the Sabarmati, Mahi, and Nerbudda rivers, either in British territory or in the adjacent Native States. If such sites can be found, we think that canals may, with advantage, be constructed from these rivers for the protection of parts of Ahmedabad and Kaira, and of such tracts in Native States as can be commanded. We also recommend a reconsideration of the Tapti project, if it be found that an area of rice cultivation can be relied on which will be sufficient to render the canal moderately remunerative.

357. *Bombay Deccan.*—Our principal and most important recommendations for large works have been made for the protection of the Deccan districts in the Bombay and Madras Presidencies. For the former we propose that the catchment areas of all the rivers which derive their supplies from the unfailing rainfall of the Western Ghats should be carefully examined, with a view to the construction of as many large storage reservoirs as possible, and of the works necessary for carrying the supply into those tracts in which irrigation is most urgently needed. We have examined and recommended two schemes of this kind—the Chankapur and Maladevi projects, the plans and estimates for which had been laid before us. Investigations, which have been put in hand on our recommendations, are also in progress in connection with proposals for the construction of storage works on the Gujauni and Ghataprabha rivers, which will feed the proposed Nira (right bank) and Gokak Canals. We have had an opportunity of seeing the results of the surveys for the former of these works, on which we have commented in Part II, paragraphs 177 and 178. These investigations should be continued until every river basin has been exhaustively examined, and we hope that many other projects may be proposed. The works will be very costly and unremunerative, but they will give protection to many tracts which are more urgently in need of it than any other part of India.

358. *Madras.*—For the Deccan districts of Madras we have recommended that immediate steps be taken to improve and extend the Kurnool-Cuddapah Canal, and to make a complete investigation of the Tungabhadra project, which, if carried out, will be one of the largest and costliest irrigation works in India. The work is hardly likely to prove remunerative, but we hope that a net-revenue may be relied on which will suffice to justify its construction as a valuable famine protective work.

359. Other large works which have been proposed in Madras are storage reservoirs on the Cauvery and Kistna rivers. It is hoped that it may be possible to sanction both of these works, or at least the former, on their merits as works which are likely to be productive; but both schemes will have a protective value which will justify sanction being accorded to them, even if there are doubts as to their proving fully remunerative.

360. *Bengal.*—We have proposed that a scheme for a large storage work and canal on the Karamnassa river, to irrigate the Bhabua Sub-division in the Shahabad district, be investigated; and we recommend its construction if it can be anticipated to yield a return equal to that of the Sone Canals. We have also considered the proposed Bagmati Canal for the irrigation of a large area in the Muzaffarpur district; but do not recommend its prosecution, at any rate until some experience has been gained on a smaller and less expensive work, such as the Kamla project in Darbhanga, of the extent to which the cultivators in these

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Northern Bihar districts are likely to avail themselves of facilities for irrigation, and the amounts which they will be willing to pay for them.

361. *United Provinces.*—In regard to the United Provinces, we have strongly recommended the construction of the Ken Canal which will protect the greater part of the Banda district in Bundelkhand—a district which suffered so severely from famine in 1896-97. We have not been able to recommend the great Sardah Canal project, to which reference was made in the Reports of the Famine Commissions of 1880 and 1898, as the greater part of the tract commanded is not in urgent need of canal irrigation, to the introduction of which both the landowners and the most experienced local revenue officers are strongly opposed; but we think that a smaller work might be contemplated for the irrigation of portions of Hardoi and adjoining districts, where protective irrigation is urgently needed. We have also suggested the possibility of diverting some of the Sardah water into the Ganges above Narora, so as to set free a portion of the supply in the Upper Ganges. Some of this may be utilized in the extension of irrigation in Bijnor and Budaon, and the balance be diverted, part to the Agra Canal *viâ* the Hindan river, and part into the Eastern Jumna Canal below Saharanpur. If this scheme is feasible, it will be possible to allot to the Western Jumna Canal a much larger share of the cold-weather supply of the river Jumna; and this extra supply will be of the greatest possible value, as affording a means for the extension of irrigation in those portions of the unprotected tracts in the Hissar and Rohtak districts which can be brought under command.

Small State Irrigation Works.

362. *Field for construction of small works.*—We have now summarized all our recommendations in respect of large irrigation projects likely to cost more than 25 lakhs each. There is, however, a wide field for the construction of works of a humbler class, the majority of which will probably not cost more than ten lakhs each, while some may cost even less than one lakh. There is a great deal to be said in favour of such works. They afford protection to many tracts which cannot be brought within the scope of larger and more ambitious schemes; they involve much less financial risk; and, on most of them, work can be started for the purpose of employing relief labour, with some assurance that the works are likely to be completed, as their completion will not entail very heavy charges on the State.

363. *Remunerative works.*—These smaller works are of two classes: some may be recommended as likely to be directly remunerative apart from their protective value; while others may be proposed on their protective merits alone. Foremost among the former class may be placed all extensions of existing works, the cost of which is chargeable to the open capital account. Such extensions are, for obvious reasons, almost always certain to be highly remunerative; and there has hitherto been little difficulty in obtaining money for their construction when they are extensions of works which have been classed as, and have actually fulfilled the conditions of, productive irrigation works. In the case of other works, such as the inundation canals in the Punjab and Sind, there are at present difficulties in obtaining funds which we should like to see removed. In many provinces also, such as Madras and the Punjab, there is room for the construction of new works, of smaller size than those which have generally been sanctioned as productive or protective, the construction of which has been prevented by the fact that the cost was chargeable against general revenues.

364. *Small works in Central Provinces and elsewhere.*—There are other small works which are never likely to be directly remunerative, but which we have no hesitation in recommending, as we have recommended many major works, on the ground that they afford the only means of providing protection against drought to tracts that are greatly in want of it. Foremost among these we would place the works which we have proposed in the rice-growing districts of the Central Provinces. But we hope that many works of the same kind may be possible in other tracts, such as are to be found in Gujerat, Berar, Chota Nagpur, and Bundelkhand; and that the programmes of famine relief works

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may before long include a great number of these works after sites have been carefully selected, and estimates have been prepared in all necessary detail. Almost all the works which we have recommended in the Rajputana and Kathiawar States will probably be small works, costing less than 25 lakhs each, with varying degrees of productiveness; but it is possible that one or two larger works may be proposed.

365. *Works for which capital accounts are not kept.*—The works, which we have hitherto been considering, are works of sufficient size and importance to justify the maintenance of capital and revenue accounts, or generally those which will cost not less than Rs. 50,000. We have, however, also advocated a more liberal expenditure on the smaller works for which no capital accounts are maintained, but for the upkeep of which Government has undertaken the responsibility.

Private Irrigation Works.

366. *Great importance of private works.*—We have next to consider the scope which exists for the extension of irrigation by means of private works. We desire, in the first place, to repeat that this question is undoubtedly of at least equal importance to that of extension by means of State works. We have shown that, out of a gross area of 44 million acres annually irrigated in British India, no less than 25½ millions, or 58 per cent., are irrigated by private works. If we eliminate Sind, where there is practically no scope for private works, the proportion becomes 60 per cent. In view of these figures, we cannot avoid the conclusion that as great an increase may be effected in the area under protection by assisting and stimulating the development of private works as by constructing new State works. Not that we advocate one to the exclusion of the other; both are equally necessary and each must be regarded as the complement of the other. The question of developing private irrigation works is, however, one which presents many difficulties. Care must be taken that assistance is not given in such a manner as to discourage all individual effort, by which so much has been done in the past and much more may be done in the future. We have expressed our views at some length in Chapters V and VI, and the recommendations which we have ventured to make may be thus summarized:—

(i) A development of the present system of *takavi* advances for agricultural improvements, and, among other measures, a lengthening of the time to be allowed for repayment of the loans, and a reduction in the rate of interest.

(ii) Grants-in-aid, in tracts in which the people have become impoverished by famine, to those who have the will but not the means to undertake works of improvement.

(iii) More definite assurances, where these are necessary, of permanent or long-term exemption from enhancement of assessment on account of agricultural improvements.

(iv) The more extensive employment of relief labour on agricultural works, even when these will benefit only private individuals who will pay nothing in return for them; and the systematic inclusion of such works in the programmes of famine relief works.

367. *Expenditure involved.*—Proposals (i) and (ii) will entail heavy expenditure, but all or almost all of that incurred under (i) will be ultimately recoverable, and will involve no actual charge on the State if the rate of interest is not fixed unduly low. If the advances and grants-in-aid are judiciously distributed, the money will be well spent, and the only limit which we would propose to expenditure, is that which this condition imposes. We fully recognize that progress in private improvements, to be healthy, must be gradual, and that it will be unwise to force the pace; although we think that it might be quickened if many of the existing obstacles were removed, and if greater facilities were offered to those who are willing to take advantage of them. As to cost, we have proposed a programme of State irrigation works which, if carried out, will, within the next twenty years, effect an increase of about 6½ million acres in the area annually irrigated and entail, when the works have been completed, an annual charge on the State of 74 lakhs, subject to whatever reduction in the future cost

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of famine may be attributable to the works. It is not possible to estimate, with any approach to accuracy, the additional protection that will be afforded in the same period by extensions of private irrigation works, but practically the only burden imposed upon the State by these works will be that due to the grants-in-aid for which we have suggested an annual provision of 17 lakhs. Even if regard be had only to such extensions as may be due to these grants, the net cost to the State will be much smaller, relatively to the area irrigated, than in the case of protective State works.

Artesian Wells and Subsoil Water Survey.

368. *Artesian and sub-artesian waters.*—The general geological conditions of India, and the results attained by the utilization of artesian waters in other countries where the conditions are more favourable, render it certain that the area which can be irrigated from these sources must always be comparatively insignificant. We have, however, recommended that experimental borings should be made in any tract liable to famine, in which the conditions may appear exceptionally favourable for artesian action. There is more hope of obtaining useful results by connecting the ordinary wells with sub-artesian sources of supply, from which the water rises above the level of the surrounding ground-water, although the hydrostatic pressure is not sufficient to force it to the surface. We have recommended that, in suitable localities, assistance should be given to the people in making borings for the purpose of tapping these supplies, and that the results should be systematically recorded in a subsoil water survey.

Programmes of Relief Works.

369. *Detailed estimates essential for irrigation works.*—The actual cost to the State of the irrigation works, public and private, which we propose, will be considerably reduced if relief labour can be employed on them which would otherwise be employed on works of more doubtful utility. An ideal programme would comprise only works of a protective character, and a few other public works which it may be proposed to carry out, famine or no famine. If our proposals for the extension of public and private irrigation works are generally accepted, the detailed estimates for these works will form the backbone of the programmes of public and village works. It is on this account necessary that the preparation of detailed estimates for new works should be a long way ahead of actual construction. We hope, indeed, that many of the works which we propose may be not only begun, but completed before famine occurs; and that, instead of providing the means, they may actually prevent the necessity for the employment of relief labour. But, whatever works may from time to time be put in hand, we recommend that detailed estimates should be prepared for all works of the kind recommended, which can be proposed in a district; until all have been submitted, sanctioned, and reserved for execution in due course or whenever it may be necessary to find employment for relief labour. It is true that, in some cases, this may involve a recasting of a project when it is put in hand some years after the original sanction, and also that it entails some immediate extra expenditure on establishment; but effective programmes of famine works cannot be prepared without cost; and in no other way can any scheme for the extension of protective irrigation works be made to fit in with an effective programme of famine relief works.

370. We are not indeed sanguine enough to suppose that there will always be on hand a sufficient number of approved projects for the extension of irrigation by public or private works, to provide employment for all the labour that may require it. There are many districts in which this will perhaps never be the case, but it is unavoidable only in those in which there is actually no scope for such projects. In all other cases some authority should be made responsible for seeing that detailed proposals for possible irrigation works are worked out and brought on to the district programmes, ready for use as occasion arises.

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Administrative Measures.

371. *Order of execution of works.*—The next question to be considered is the order to be pursued in carrying out the State irrigation works which have been recommended, and in encouraging the extension of private works. It may, at first sight, appear that the rule should be to commence operations in those tracts which are most liable to severe famine, gradually extending them to other tracts, as the protection of those first selected becomes as complete as may be possible. The tracts in which the need is greatest should, no doubt, receive the earliest possible attention, but there are many practical considerations which render it inadvisable to concentrate all efforts upon them. In the first place, the progress which can be effected in one particular tract, or on one particular work, is limited to a great extent by the amount of local labour available; and, although for certain works it may be possible to import outside labour on a large scale, it will generally be inadvisable to do so in tracts very liable to famine. An excessive concentration of energies on one tract may also involve an inconvenient derangement of the administrative machinery. Greater progress will, therefore, be made by multiplying efforts in widely distant tracts than by concentrating all efforts in one particular locality. Apart from this, there is always uncertainty as to the province or district in which famine may next appear. It is, on this account alone, desirable that all effort to prevent famine should be diffused rather than concentrated; and that in all provinces systematic organization and arrangements should be made at once, not only for the preparation of protective projects which may be entered in the programmes of relief works, but also for their gradual and orderly execution in accordance with a prescribed plan. We recommend, therefore, that operations should be started all along the line, and that every province be allowed to open its own plan of campaign. At the same time it is, of course, expedient that the greatest and earliest activity should be displayed in those provinces or parts of provinces in which, according to past experience, there appears to be the greatest danger of famine, or which are in most urgent need of protection.

372. *Co-operation of departments.*—It has been shown that, for greater protection against famine, reliance must be placed, not only on new State irrigation works, but also on the extension of irrigation by means of private works. For the construction of new State works the officers of the Public Works Department will be responsible; on the Civil officers will devolve the duty of encouraging and stimulating private effort. Thus the two departments will not only be closely associated in devising measures of protection and programmes of relief works, but each will, even in its own sphere, require the co-operation and advice of the other. It is of great importance that the revenue officers should be freely consulted during the earlier stages in the preparation of projects for State irrigation works. Even in the case of works which are certain to be remunerative, many mistakes in the alignment and construction of the distributary system will be avoided, if full and complete information is given of the nature and distribution of soils within the area to be commanded. In the case of works which are undertaken solely in consideration of their protective merits, and which are likely to impose a permanent charge on the State, something more than this is required to ensure that water will be distributed to the best advantage among the villages in which protection is most urgently required. We have had the benefit of an interview with Sir Edward Buck, K.C.S.I., who explained to us the closely detailed system of agricultural statistics instituted by him while at the head of the Agricultural Department. These statistics are now maintained for every village in all those provinces and parts of British territory in which the need for extending irrigation is at all urgent or pressing. They cannot fail to be useful to irrigation officers who ought to be acquainted with, and to make full use of, them before designing any extensions of irrigation. The cost of famine relief in the past, in any particular tract, and the amounts of remissions and suspensions of land revenue, are factors that will also have to be considered in connection with particular schemes for protection. On the other hand, the Civil officer will often be glad to receive the co-operation of the Irrigation officer in preparing his own schemes for village works and agricultural improvements, not only in the selection of suitable sites, but in the

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preparation of standard plans and specifications, and of rough estimates of cost or quantities of work to be done.

373. The experts of the Agricultural Department will also often be able to give very useful advice in connection with schemes for the extension of irrigation. The Famine Commission of 1901 have drawn attention to the assistance which this department may render to the work of protection, and have remarked that "the steady application to agricultural problems of expert research is the crying necessity of the time." To the long list of subjects of inquiry suggested by the Commission, we desire to add that of the application of water to cultivated crops, which is of such importance that we have considered it separately in Chapter XI. There is no country in which a wider field and better opportunities exist for such inquiries than in India; and there is none in which the results attained are likely to be of greater practical importance.

374. *Central Board recommended.*—In Chapter IV we have proposed a rough forecast of the expenditure which may be incurred in extending the area under protection of State irrigation works; and in Chapter VI we have ventured to give an idea of the expenditure which may, in our opinion, be advantageously incurred for some years to come in the encouragement and development of private protective works. These two forecasts, taken together, constitute a provisional programme of future protective operations. It is put forward only as a basis of discussion. The final programme will depend on the general view taken by the Government of India of our recommendations, on questions of financial expediency, and on the detailed working plans which Local Governments may hereafter submit for their several Administrations. But, whatever final programme may, after due deliberation, be eventually adopted, we desire strongly to recommend that some special arrangement should be made to ensure that it is faithfully, vigorously, and continuously prosecuted. We cannot but recognize the danger that any programme, however carefully devised, may, in course of time, become almost a dead letter unless measures are taken to prevent it. We venture to suggest that some Central Board or Authority should be constituted, and invested with the responsibility of regularly watching and reporting progress under all heads of the programme, and of guarding against any material deviation from the working plan for each province being made without the express sanction of the Government of India. Minor deviations in matters of detail might be permitted with the sanction of the Board. We recognize that circumstances may often arise which may render it impossible to carry out any programme in its entirety; but the constitution of a Central Board will prevent deviations for which there is not sufficient justification; and it will facilitate re-adjustments of the programme, so that when slow progress is unavoidable in one province, it may be compensated for by greater activity in another.

375. *Inspector-General of Irrigation.*—The responsible technical adviser of the Government of India is the Inspector-General of Irrigation, who is also Secretary to the Government of India in the Irrigation, and Roads and Buildings Branches of the Public Works Department. The adoption, in whole or in part, of the programme of new State irrigation works will give a great deal of extra work to this officer. We think it of great importance that he should continue to examine all projects which may be submitted to the Government of India; that he should be free to spend a considerable portion of the cold weather in visiting the different provinces, inspecting works in progress and the sites of proposed new works, and in conferring with local officers; and that, if necessary, special arrangements should be made for relieving him of all but the most important of his duties as Secretary at such times.

376. *Financing of State works and loans for private improvement.*—In Chapter VIII we have put forward certain proposals for the future classification and financing of State irrigation works; and in Chapter VI (paragraph 212) we have made some observations on the financing of loans and grants-in-aid for agricultural improvements of a protective nature. The proposals are of a technical character, and they cannot be conveniently summarized; but their main object

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is to ensure a regular supply of funds for the execution of a programme of operations which shall not be liable to interruption to meet budget exigencies. If this end can be as surely attained in any other way, we do not desire to press the particular proposals which we have made, and which will no doubt be considered on their merits.

377. *Revenue and engineer establishments.*—For the prosecution of the programme of new State irrigation works which we have recommended, a large and permanent increase in the strength of the engineer establishment will be necessary. In regard to this, some observations have been made in Chapter X. It is hardly necessary to add that a corresponding increase will be required in most of the subordinate establishments. Some increase in revenue establishments will also undoubtedly be required, to give full effect to that part of our programme which relates to private irrigation works. The distribution of *takavi* advances on a scale so much larger than that hitherto known, the allotment of grants-in-aid to impoverished cultivators, and the preparation of effective programmes of agricultural improvements and village works, cannot be carried out without additional establishment. We are, however, unable to say what the increase will be, and can only draw attention to the fact that it may be considerable and must be contemplated.

378. *Water-rates.*—There is one point on which we desire to record an emphatic opinion. We have not hesitated to recommend a large unremunerative expenditure for the sake of affording protection to many tracts which are urgently in need of it; and we recognize that, even after irrigation has been introduced, it will be necessary for some time to remit a considerable share of the rates until the people have learned to appreciate the advantages of irrigation. But when that time has come, we think that there should be a gradual enhancement of rates, until the charges for water are equal to what it is really worth; that is, until the rates charged to an occupier are the maxima compatible with a full demand for water, and those paid by the owner are a fair share of the increase in the value of his net assets due to irrigation. We have estimated that the completion of all the new State works which we propose, may involve a permanent net charge for interest amounting to 43 lakhs per annum; but, if this principle is continually acted on in practice, we hope that there may eventually be a material diminution of these charges. There are some schemes that are never likely to be fully remunerative; but all should gradually become less and less unremunerative if care is taken to raise the charge for water as circumstances warrant. From a mere protective point of view, the more profitable irrigation works become, the greater will be the readiness and the capacity of Government to sanction further extensions. We have not attempted to form any opinion on the adequacy of the rates charged for irrigation in the different provinces which we have visited; but we have been impressed by the fact, to which we have drawn attention in our Bengal Chapter, that the securely protected and flourishing tract in South Bihar, which is irrigated from the Sone Canals, pays so little for the water advantages which it has now enjoyed for 30 years, that a charge for interest, amounting to over 5 lakhs, has to be met annually by the general tax-payer.

379. *Legislation.*—There are many points on which, in the course of this report, we have ventured to recommend legislation. All legislation that can be regarded, rightly or wrongly, as likely to affect prejudicially a number of private interests, is, we are well aware, certain to be strenuously opposed, however desirable it may be in the interests of the community at large. No doubt, also, the expediency of new legislation may depend on many other considerations than those which are advanced by its proposers. We have not, however, thought it necessary to state in anticipation all the arguments that may be urged from different points for leaving matters alone. But we have thought it our duty to point out that there are, in many provinces, obstacles to the extension of irrigation by State or private works, and to the utilization to the greatest public advantage of the water-supply of the country, which cannot be effectively removed without legislation.

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Native States.

380. In Chapter XXI we have endeavoured to describe the present state and practice of irrigation, and the scope which exists for further development in the Native States which we visited during our tour, or in adjacent States with regard to which evidence has been offered to us. We have referred to the obstacle which territorial or political boundaries present to the extension of irrigation in India by means of State works. Cases in which these difficulties arise are not likely to be so numerous in the larger and self-contained States, such as Hyderabad or Mysore, as in those of Rajputana, Central India, Kathiawar, and Gujerat, many of which consist of several and widely scattered blocks. But even in the larger States difficulties may arise when the interests of the States and those of the British districts beyond their borders are in apparent or real conflict. In all such cases the wider appreciation of the necessity for protective irrigation, the public spirit of the ruling chiefs, and the good offices of the Imperial Government should suffice to bring about an arrangement which will be eventually satisfactory to all parties.

381. We have recommended that comprehensive surveys be made of all river-basins in the Native States of Rajputana, Central India, Kathiawar, and Gujerat, so as to obtain a full programme of the most promising projects for canals and storage works. These surveys have already been started, with the sanction of the Government of India, in the Rajputana Agency, under the general supervision of Colonel Sir Swinton Jacob, K.C.I.E., R.A., whose high and special qualifications for the work to be done are beyond question. We have recently been informed that a number of excellent sites for storage works have already been found, including one for a large reservoir on the river Banas in the State of Mewar; many of the States have asked for assistance and advice in matters of irrigation, while the ruling chiefs are displaying a personal interest in the results of the investigations.

382. Our inquiries in Native States were not, however, confined to the subject of State irrigation works, *in esse* or *in posse*. We have obtained much valuable and interesting information as to the measures adopted for the encouragement of private irrigation works, and for the employment of relief labour during the recent famines; these may be usefully compared with the systems in force in adjacent British districts where, under similar local conditions, the same difficulties have to be overcome. Here, as elsewhere, these questions form an important factor in the whole problem of protection.

Conclusion.

383. Our general conclusion is that there is a wide but not unlimited field in which the Engineers and Civil officers can work together for the protection of the country from famine; partly by the construction of new State irrigation works, and partly by encouraging and stimulating the extension of irrigation by means of private works. Both methods will involve heavy expenditure on the part of the State, upon which there will be no direct return, although it may be justified by the value of the protection afforded. We have endeavoured to indicate not only all the possibilities, but also the limitations to extensions of irrigation. It has been incumbent on us to consider the latter, but it is the former on which we prefer to dwell, and to which we invite the more earnest consideration. It is more important to realize what irrigation can do, than what it cannot. The whole of India can never be protected from famine by irrigation alone, but irrigation can do much to restrict the area and to mitigate the intensity of famine. We cannot but repeat, in respect of the measures that we propose, the wise warning of the last Famine Commission that their enduring success will depend no less on their effect in evolving a spirit of self-help and thrift among the people than on their efficiency in securing the crops from

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drought. Nevertheless, we hope that, if they are vigorously and systematically carried to completion, they will at least give all the protection from drought that irrigation is capable of affording; and that the additional security thereby conferred on the agricultural classes of India may tend to develop amongst them that prudence and practice of thrift without which irrigation of itself will be of little permanent or lasting value.

COLIN SCOTT-MONCRIEFF.

T. HIGHAM.

J. MUIR-MACKENZIE.

P. RAJARATNA MUDALIYAR.

Lucknow, April 11th, 1903.

G. I. C. P. O.—No. 993 I. I. C.—9-7-1903—3,900—J. E. F.

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